The Engineer

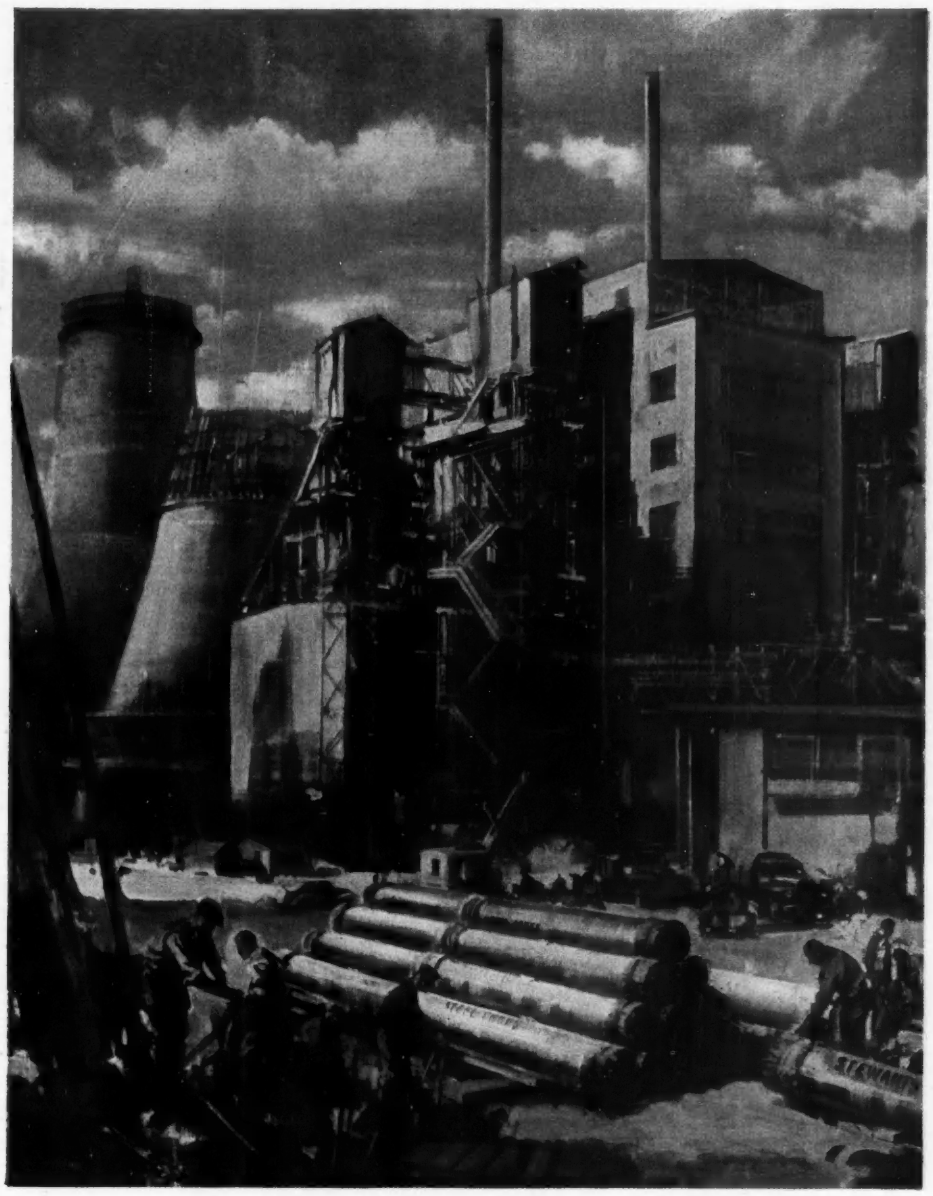
VOL. 202—JULY TO DECEMBER, 1956

LONDON:
28, ESSEX STREET, STRAND, W.C.2

The Engineer

UNIVERSITY OF MICHIGAN
AUG 10 1956
ENGINEERING LIBRARY

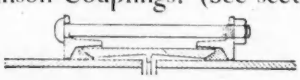
JULY 6, 1956 28 ESSEX ST., STRAND, LONDON, W.C.2. TWO SHILLINGS



THE STEEL TUBE AGE

16 inch S & L steel water pipes at Calder Hall,
Britain's first atomic power station.

These pipes are protected externally with bitumen asbestos sheathing and internally with bituminous solution. They have plain ends for use with Viking Johnson Couplings. (See section below).

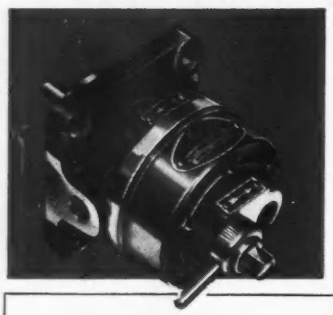


STEWARTS AND LLOYDS LIMITED

GLASGOW · BIRMINGHAM · LONDON

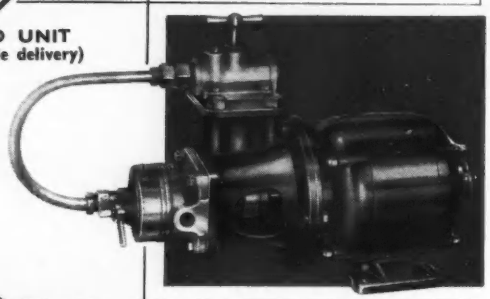
The largest manufacturers of steel tubes in Europe

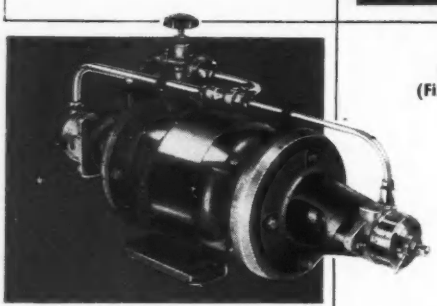
S&L



STANDARD UNIT
(Fixed or variable delivery)

MOTORISED UNIT
(Fixed or variable delivery)





SPECIAL UNIT
(Fixed or variable delivery)

This is why Savery Hydraulic Pumps have it all ways

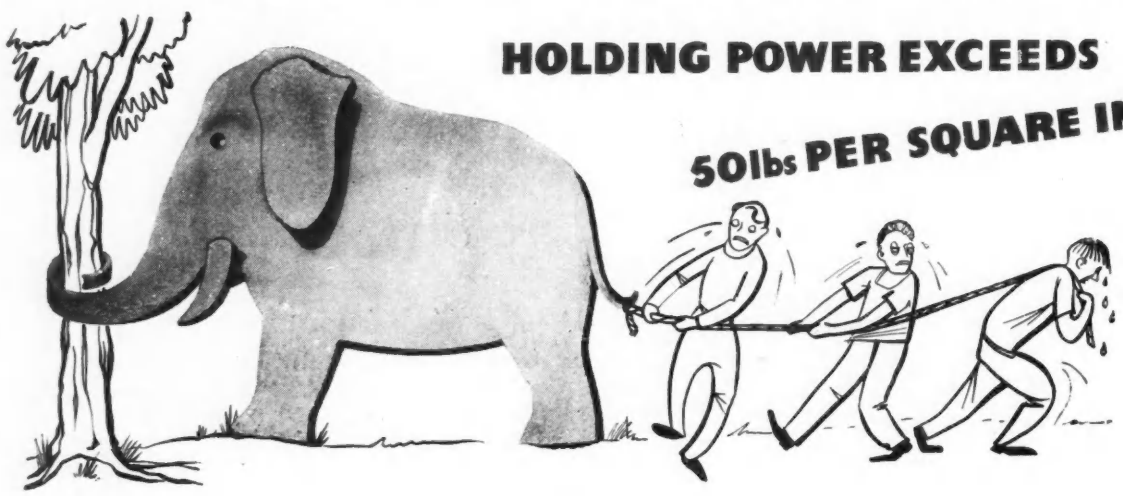
SOME PROVED APPLICATIONS

Hydraulic feeds in machine tools, textile machinery, drilling equipment, test rigs,
Lifting gear in mechanical handling.
Hydraulic equipment in aircraft (80,000 supplied to aircraft industry).
Hydraulic pressure in testing machines.
Metering and mixing equipment.
Pressure lubrication.
Oil burner feed equipment.

Write for further details to

Thomas Savery Pump LTD.

BRACEBRIDGE ST · BIRMINGHAM 6 *Tel: ASTON CROSS*



More than 1,000 factories have done away with bolts, grouting, damaged floors; made layout changes a matter of hours; practically eliminated machine vibration. How? By adopting the Croid-Cooper method of machine installation where machines are stuck down on a felt base with a holding power of 50 lbs. to the square inch. Send for details to-day.

CROID 65
MACHINE FIXING GLUE
COOPERS FELT

COOPER & CO. (B'HAM), LTD.

BRYNMAWR BRECONSHIRE

Telephone: Brynmawr 312. Telegrams: Felting Brynmawr.

Registered Office and Works: Little King Street, Birmingham, 19

THE ENGINEER

VOL. 202 No. 5241 JULY, 6, 1956

CONTENTS

LEADING ARTICLES—
World Power ... 1
Rural Ride ... 1
Britain's Neglect of Transport ... 2

ARTICLES—
British Coal Utilisation Research Association ... 3
British Engineers Small Tools and Equipment Company, Ltd. ... 3
Cantilevered Stand Roof. (Illus.) ... 27
Cleaning Process for Castings. (Illus.) 25
Combined Continuous Backing Bar and Clamp for Cylindrical Welding. (Illus.) ... 26
Direct Observation of Defective Crystal Lattices. (Illus.) ... 6
Engravings of 1871 ... 22
Experimental High-Speed Launch. (Illus.) ... 26
Fifth World Power Conference. No. III. (Illus.) ... 13
Finlarig Power Station ... 25
Folding Caravan. (Illus.) ... 27
Gas Turbine Developments in Aeronautics. (Illus.) ... 16
Heavy-Duty Plate Shearing Machine. (Illus.) ... 27
Institution of Civil Engineers' Conversazione. (Illus.) ... 18
International Machine Tool Exhibition. No. III. (Illus.) ... 7
James Spencer Hollings, C.B.E. ... 3
Jubilee of British Brown Boveri, Ltd. ... 3
North Scottish Navigator Chain ... 6
Performance Characteristics of Free Piston Compressor. (Illus.) ... 4
Royal Show at Newcastle upon Tyne. No. II. (Illus.) ... 23
100 Years Ago ... 3

CONTINENTAL SECTION—
Eighth Annual Report of U.N. Technical Assistance Board ... 29
Plastic Pipework ... 29
Two-Way Lifting and Tipping Wagon. (Illus.) ... 30
Heavy-Duty Roughing Roll Lathe. (Illus.) ... 30
Suction-Clamped Test Indicator Stand. (Illus.) ... 30

AMERICAN SCENE—
Automotive Developments ... 31
Construction of Research Reactor at M.I.T. ... 31
Fabrication of Frictional Parts from "Teflon" Fibre. (Illus.) ... 32
6000MeV Synchrotron Particle Accelerator at Cambridge ... 32
Control of Cracks in Reinforced Concrete. (Illus.) ... 33

LETTERS AND LITERATURE ... 20
LETTERS TO THE EDITOR—
Effect of Distortion of a Stiff-Jointed Frame on its Plastic Collapse Load ... 20
LITERATURE ... 20

NEWS AND NOTES—
British Patent Specifications. (Illus.) ... 35
British Standards Institution ... 36
Catalogues and Brochures ... 36
Forthcoming Engagements ... 36
Industrial and Labour Notes ... 28
Launches and Trial Trips ... 36
Personal and Business ... 34
Technical Reports ... 19

WORLD POWER

The World Power Conference, when it is spoken of in circles remote from the ways of engineers, brings to mind an impression of some very important political gathering of the nations. But there are two concepts of power, one the perennial shuttlecock of diplomacy, the other a more sophisticated and more creative idea, that of the utilisation of the varied forms of energy revealed by scientific discovery. The promoters of this second concept discipline their thought more systematically than do their political cousins; their achievements stem from painstaking experience and calculations, and from plans which quite normally extend seven years or so into the future. The progress and the future problems of their work were all discussed at Vienna two weeks ago, when the Fifth World Power Conference was held.

The World Power Conference is unique in giving an overall summing-up, once every five years or so, of the world's fuel and power problems. The field is so vast, and individual advances in the different subjects are so frequent, that an atomistic approach is essential in appraising the progress achieved. But the Conference allows both an examination, section by section, and also a bird's eye view of the whole. We have tried to pick out some of the more striking new developments and trends in our conference review, which concludes on page 13; but from about three hundred papers and a week of discussion, obviously we cannot claim to have been comprehensive. Rapid technical advance, resulting in greater economy and reliability, is, of course, the greatest factor affecting progress and expansion. The overall problem integrating all these individual advances is, however, an economic one. In all countries, the demand for energy is rising. Annual electricity consumption in Europe is increasing at about 8 per cent annually, and an increase of 4½ per cent annually in the world's gross energy production was noted; a Russian speaker quoted a 13 per cent annual increase in electricity generation in that country's programme. Such a scale of expansion demands large investments—about 7 per cent of the total investment in the highly industrial countries of Europe, it was stated. How much should be invested in these industries, it was asked, and how much in other sections of a country's economy, when capital resources are limited? Less spectacular, but equally necessary, investments can easily be starved of capital, to the detriment of the whole economy. The host country of the Conference, Austria, is particularly affected by this dilemma. Even so, Austria, and the other countries too, almost without exception, plan to spend vast capital sums on developing the fuel and power industries. The optimism shown by delegates in future economic conditions was considered to be one of the most striking facts of the Conference, an optimism which was considered reasonably well justified.

The general picture was thus one of rapid expansion; especially in Europe, however, another factor was important, namely, that of shortage of indigenous fuels; this problem was outlined in a recent O.E.E.C. report, discussed in these columns on June 8th last. A basic technical advance offsets it to some extent, however. Since the previous World Power Conference was held economic nuclear power generation has come within reach. In spite of warnings about uncertainties in the development of nuclear power, and the small total contribution which it will make at first, the prospect of a significant contribution from that source, in not too many years' time, was a factor influencing many of the delegates. Here, with the early trials of the Calder Hall reactor successfully completed, a note of confident optimism was noticeable in the contributions from several British delegates. As one of them remarked, the advent of nuclear power had made the future of the fuel and power industries "less certain but more interesting."

"A RURAL RIDE"

This week we have visited the Royal Show at Newcastle upon Tyne. Such a visit can quite appropriately be likened to a modern "rural ride," although, in common with the thousands of others who were there, we were unable to make the "ride" on horseback or in a jeep! Either method of locomotion would have been welcome, for the showground occupies about 160 acres, and a tour of the machinery avenues alone is an exhausting business. But it is a tour that is rewarding. For it emphasises, particularly in an industrial area like Tyneside, the value of the affinity between rural and urban activities which has become more and more evident in the post-war years. It is important to bear in mind that between

1939 and last year the total tillage of the United Kingdom increased from 8,781,000 acres to 11,323,000 acres. With a steadily shrinking agricultural labour force, so extensive a tillage acreage as to-day's could not be productively cultivated without the mechanical aids devised and produced by engineers. Furthermore, the contribution made in the last decade to our export trade by tractors and agricultural machinery has become increasingly valuable. At present, it is true, the home demand for some classes of agricultural machinery is receding, and so far this year there have not been such big sales of British tractors in some overseas markets. But that is in no way a reflection upon the quality and high standard of efficiency of the British product. The reasons for the decline in sales are those same economic ones that are affecting other sectors of industry.

It would be unwise, however, to assess the worth of the Royal Show merely by its value as a market place. Admittedly our tour of it this week revealed fewer completely new designs than have been seen at some shows in recent years. Though it should not be forgotten that, lately, agricultural machinery makers have shown a tendency to save the launching of their new products until the Smithfield Exhibition which is held in London in December. Yet the smaller number of essentially new or revolutionary machines at this year's " Royal " does not indicate any drift towards stagnation on the part of designers and producers. Far from it. There were to be discerned many improvements to and refinements in existing designs, all of them directed to the more efficient and safe operation of machines that, not so long ago, were looked at askance by farmers who would now agree that they could not possibly do without them ! Herein, perhaps, is the most valuable aspect of the engineer's work for agriculture ; it is a work that has been going on for a very long time. We could not resist a rapid review of some of that work as we made our way around the machinery section of the Royal Show. We recalled, for example, that exactly a century ago, in the year in which this journal began publication, the Royal Agricultural Society organised a competition with " a premium of £500 for the best steam cultivator which would turn up the soil and become a substitute for the plough and the spade." There were only two entries, and one was disqualified on the ground that the competitor worked with a " scarifier which did not invert the soil." The other competitor was John Fowler, who, it was generally agreed, presented an " economical application of steam power to the land." He was not then, however, awarded the premium ; for the judges, it appears, after careful calculation, reached the conclusion that the cost of Fowler's system of steam ploughing was 7s. 2½d. per acre, whereas with horses it *might* have been done for 7s.! We mention that particular recollection merely to emphasise that agricultural engineers like John Fowler and his contemporaries and their successors were not deterred, by temporary frustrations, from pressing on with those tasks to which they applied their minds and their hands. Mechanised agriculture has passed through the age of steam power, with all its glory and usefulness, to the age of internal combustion engine power, and to the day of electrical power, with their vast resources. One thing, however, has not changed, and that is the pioneering spirit of those who are now engaged in the complex business of agricultural engineering The " rural ride " which we have enjoyed this week has reaffirmed our former conclusions on that score.

BRITAIN'S NEGLECT OF TRANSPORT

No other industrial country since the war has, we believe, so neglected to improve its inland transport facilities as has this country. The story is so astonishing that it is difficult to believe it true. Since the war successive Governments have encouraged basic industries such as iron and steel, coal, gas and electricity, to modernise their plants and expand their outputs. Equally private industry has been encouraged and exhorted to plough back profits to modernise and to expand. Only in that one industry which is, if anything, even more basic than all the rest, has growth been checked ; only in transport has expenditure upon modernisation and improvement—and even upon maintenance !—been frowned upon ; only in that field has it been claimed that the nation cannot afford it. In a part of the Report of the British Transport Commission for 1955, which lies before us as we write, it is explained how deficits on years' workings have repeatedly occurred because, under regulations laid down by the Government it has never been possible to raise fares and charges sufficiently soon after wages and other costs have risen in an inflationary economy. It is added, " Another factor in the deficit has been the control over capital investment . . . this will continue to depress . . . . competitive power for years to come. The restrictions imposed on the replacement of out-of-date or worn-out rolling stock, buildings and equipment have been particularly severe. Excessive maintenance costs have been inflicted on the undertaking and the delays in covering the wartime arrears have meant that reserves inherited to finance those arrears at 1947 prices proved quite inadequate at the prices ruling when the work was permitted. Even more important has been the effect on efficiency. . . ." The roads equally with the railways have suffered the same mistaken parsimony. But at least, there, the Government has been unable to prevent large numbers of new cars, coaches and lorries coming on to the highways, even if thereby the inadequacy of the highways to bear the traffic has led to uneconomic delays and unnecessary loss of life. Until last year when the Government relented railways suffered even more severely than the roads.

The consequence, as the report implicitly makes clear, is that the salvation of the railways now depends upon the carrying out of the modernisation plans at the highest practicable speed. The matter is urgent. For, despite a steady increase over the years in the amount of freight and number of passengers to be carried, the corollary, of course, of expanding industrial output, the trend of traffics on the railways is at present rather downward than upward ; and even in relation to the movement of such a mineral as coal, the report contains the ominous words : " the road vehicle is making inroads into what was once regarded as a rail monopoly." In the carriage of passengers the railways have long since ceased to be predominant ; and in the carriage of goods they are fain now to admit that probably not more than one-half travel by rail (statistics from road sources place the figure much lower). In the report it is claimed that part of the railways' failure to compete with road services is due to the fact that though the draft Railway Merchandise Charges Scheme was lodged with the Transport Tribunal in March, 1955, the railways are " still without that greater freedom to charge and hence to compete, which Parliament intended them to have " under the 1953 Transport Act. That is fair enough. But other excuses offered amount to special pleading, especially those relating to the increase in numbers of " C " licensed vehicles, for their owners would not buy them unless, perhaps on broader grounds than transport costs alone, they believed them economic ; to long distance coaches which may have the advantage conferred upon them by licensing authorities of operating with high average loadings but which have, nevertheless, to put up with a speed limitation and to operate on congested roads ; and to private cars whose owners presumably rate convenience and comfort above economy in choosing to use their private transport rather than public transport, are heavily taxed for the privilege and get remarkably little in return for it ! The final comment must be that the figures given in the report show, over the whole field of transport—and it is admitted by the railways—that road transport is now of the greater importance to this country's economy. What folly it is then not to expend anything approaching an adequate sum annually on road modernisation and motorway construction !

A Seven Day Journal

British Engineers Small Tools and Equipment Company, Ltd.

To mark the occasion of the International Machine Tool Exhibition, the British Engineers Small Tools and Equipment Company, Ltd., better known as B.E.S.T.E.C., held a dinner in London last Friday. This export organisation of fourteen British makers of complementary tools and high-precision equipment is now represented in some sixty countries, and representatives of agents in twenty of those countries were present at the dinner. In welcoming the guests, Mr. S. J. Harley pointed out that five new companies had joined the group since the last exhibition in 1952, and that this year the B.E.S.T.E.C. stand was one of the largest at Olympia. Such an exhibition, he said, provided a welcome opportunity for overseas representatives to meet and form friendships which would be greatly to the benefit of both the organisation and themselves. In responding for the guests, Mr. Louis Polk, the president of the National Machine Tool Builders Association of the United States, praised the organisation of the Machine Tool Exhibition and said how impressive to all visitors was the range of equipment shown. In mentioning the fact that industry in the United States was at present undergoing some readjustments, Mr. Polk said that there was no suggestion of a serious economic situation arising such as that of the 1930s. It was his opinion that small economic troubles prompted manufacturers to readjust their programmes, which was to the benefit of machine tool makers who provided the means for improving productivity. Mr. Ernst Lunden, of Stockholm, then spoke on behalf of the organisation's European representatives. He said that the growth of B.E.S.T.E.C. had been impressive, and the agents in Europe were proud of the products they handled.

Jubilee of British Brown Boveri, Ltd.

To celebrate the fiftieth anniversary of the formation of British Brown Boveri, Ltd., a luncheon was held at the Dorchester Hotel, Park Lane, London, on June 29th. The company was addressed by Mr. H. Oswald, the managing director, who referred to the collaboration between Witting, Eborall and Co., Ltd., and S. A. Brown Boveri and Cie., of Baden, in forming the new company. He paid tribute to the work of Mr. A. C. Eborall, who was the first managing director and who was chairman from 1937 until his retirement ten years later. Mr. Oswald also referred to the main products of the company and to the changes in the territory covered, and went on to give particulars of a few of the contracts which had been completed. These included early turbo-generators, air compressors and blowers, the turbo-alternators in the decade 1920 to 1930 ; steel-cylinder and high-voltage steel-tank rectifiers ; multi-stage axial flow compressors for wind tunnels; exhaust gas turbine-driven blowers for supercharging diesel engines and the gas turbine locomotive, which had been running over the Western Region system since 1950. Mr. R. Vodoz, the chairman of the company, proposed the toast of " The Guests," and Mr. John H. Wedgwood replied. He gave a brief account of the operation and behaviour of the Brown Boveri all-electric pottery built for his company before the war.

British Coal Utilisation Research Association

THE British Coal Utilisation Research Association has issued its report for the year ended December 31, 1955. Apart from domestic information the report gives details of the research programmes which are divided into nine groups. Boiler firing investigations have centred upon the efficient burning of a wider range of coals in industrial plant, and the report mentions that tests using a modified shortened chain-grate stoker have resulted in an improved performance. Initial design work has begun on the means to burn inferior coals in a locomotive boiler of the " Royal Scot " class, and it is also stated that the work on cyclone combustion has continued, while the work on gas cleaning has been extended. With the support of the Boiler Availability Committee, progress has been made with the work on deposits and corrosion. In addition, there has been increased support for an investigation into gas producer practice. On the domestic side the emphasis has been upon the improvement in domestic heating as related to air pollution, and the development to the field testing stage of a small bore pipe forced circulation heating system. With regard to atmospheric pollution, work on the measurement of industrial smoke continues, and it is recorded that laboratory studies on the smoking tendency of coals have produced a satisfactory method of assessment. Further study has been given to the use of an oscillating tray in a furnace muffle for agglomerating coarsely crushed weakly caking coals, and it is stated that over 90 per cent of the feed may be processed into agglomerates 1in to 2in in diameter. Other researches concerned pulveriser trials, the results of which, when analysed, indicated a simple relationship between mill performance and coal hardness. In the section of the report dealing with the physics and chemistry of coal it is stated that chemical methods have been developed for studying the different reactive groups present, and that one product of a particular reaction is a heavy fluorinated oil, the industrial uses of which are being explored. Confirmation of previous work on the effect of inhibitors on the combustion of carbon monoxide has resulted from studies of the low-temperature combustion of cokes, and the report mentions the establishment of an approximate method for predicting the adsorptive capacity of a charcoal.

The Engineer

100 Years Ago

(JULY 4, 1856)

" THE CRYSTAL PALACE WATER-TOWERS "

" The water-towers at the Crystal Palace are among the most interesting engineering works of the present day. Some idea of their strength and magnitude may be formed from the fact that each have to support, at a height of nearly 300 feet above the ground, a body of water of not less than 2,000 tons weight. The towers are polygonal in their construction, and are 46 feet in diameter from centre to centre of the columns. They are constructed of a series of cast-iron columns and girders ; and the whole of the height is divided into tiers or galleries, reached by a winding staircase. The total height of the towers, from the first floor or tier to the top of the chimney-cap, is 279 feet, being 77 feet more than the entire height of the monument of the Fire of London. . . .

" The tank on each tower supplies but one jet of water to the lower series of fountains. The pressure on the mouth of this jet to the square inch is about 262 lbs, and the water rises to a height of 280 feet. When the tank of the water-tower is full, the total weight resting on the foundation of the tower is—water in tank, 2,000 tons ; wrought-iron in tower, 240 tons ; cast-iron in tower, 638 tons ; glass, timber, lead etc., 200 tons :—total weight of each tower, 3,078 tons. From the base of these towers iron pipes are laid conducting the water to all the fountains of the upper and lower series. For this purpose upwards of ten miles of pipes are required. Through the smallest of these pipes a person could easily crawl ; the largest would accommodate several. All form a gigantic network, spreading in every direction under the grounds round the Palace. A sum of money as large, we believe, as that expended on the whole of the Crystal Palace and its internal decorations and works of art has been expended in completing these works. The magnitude of the undertaking may be conceived from the circumstances that when all the fountains are in full operation there are no less than 11,788 jets playing at once, through which 120,000 gallons of water pass per minute."

James Spencer Hollings, C.B.E.

IT is with regret that we record the death of James Spencer Hollings, which occurred on June 21st. Mr. Hollings, who was born in 1872, was educated at Sedbergh and trained as a mining engineer. However, he was not destined to follow this profession, for in 1893 he transferred to the steel industry, where he worked under J. H. Darby, of the Brymbo Steel Company, Ltd. Mr. Hollings was associated with the company for more than thirty years and occupied the position of managing director from 1914 onwards. These years saw many developments in the iron and steel industry, and he travelled extensively to study new techniques. His travels abroad enabled him to gain a comprehensive knowledge of the industry, particularly in Germany and the United States of America. After Baldwins, Ltd. acquired the Brymbo Steel Company, Ltd., Mr. Hollings served under Sir John Roper Wright, who was associated with Sir William Siemens when the acid open-hearth method of making steel was developed. Later on, Mr. Hollings was appointed managing director and vice-chairman of Guest, Keen, Baldwin's Iron and Steel Company, Ltd. These positions he held until he retired in 1945, but he continued to serve the company as a director after that date. Mr. Hollings was an expert on blast-furnace and coke oven practice and also in the design and planning of integrated plant, and was concerned in the design of the works of the South African Iron and Steel Industrial Corporation, Ltd., and also in the planning of the East Moors Works of his own company. Besides serving on the executive committee of the British Iron and Steel Federation and the council of the British Iron and Steel Research Association, Mr. Hollings was for several years chairman of the National Association of Hematite Pig Iron Manufacturers and also of the Basic Pig Iron Producers Association. He was elected vice-president of the Iron and Steel Institute in 1938, thirty-five years after becoming a member, and was made an honorary vice-president in 1946, being awarded the Bessemer Gold Medal in the same year.

Performance Characteristics of Free Piston Compressor

By B. W. MARTIN, M.Sc., Ph.D., A.M.I.Mech.E., A.F.R.Ae.S.

There appears to be little or no published information concerning the performance of free-piston compressors over a range of operating conditions. It is for this reason that the results are presented of some experimental tests on a Junkers four-stage air compressor (Type 4FK—115), carried out in the Mechanical and Marine Engineering Department of King's College, University of Durham. It is not claimed that these results represent a complete analysis of the behaviour of the unit, but it is suggested that they give some indication of its overall performance.

THE application of a reciprocating free-piston engine to the compression of air originated at least thirty, and possibly nearly fifty, years ago. Notable contributions to the development of free-piston compressors were made in France by Pescara in the 1920s, though much experimental work had been carried out at an earlier date by the German engineer Junker, with a view to producing a reliable compressor. The free-piston arrangement consists essentially of a single-cylinder opposed, two-stroke diesel engine, driving a reciprocating compressor. The two pistons are controlled only by the gas forces which act on them, and not by the more conventional crank-connecting-rod system. This leads to constructional simplicity and compactness, together with almost vibration-free operation, and the absence of piston cylinder side-thrust. Such features are likely to be productive of a unit whose ratio of output to weight (or volume) is high. The free-piston compressor is, therefore, very suitable for use on board ship or submarine and where portable units are required, as in road work and rock drilling. It is of particular value where space is at a premium, as is the case in many factory buildings. The machine thus possesses considerable advantages which present-day industry has begun to appreciate.

Specification of Compressor

A schematic drawing of the layout of the compressor, manufactured by Junkers Motorenbau, Allach, near Munich, is shown in Fig. 1, the principal dimensions quoted being as follows :

Overall length	87in
Mean overall diameter	28in
Driving motor bore	4·53in
First stage compressor bore	8·25in
Second stage compressor bore	4·25in
Third stage compressor bore	1·77in
Fourth stage compressor bore	0·99in
Compressor piston stroke range	8·58–8·86in
Dry weight of compressor	1250 lb
Weight of each piston assembly	65·4 lb

The opposed-piston diesel engine is located in the centre section of the system. The intake and exhaust ports are uncovered by the pistons at the end of the working stroke and uniflow scavenging is provided by some of the first stage compressed air. The first and fourth stage compressor pistons are coupled to the scavenge port diesel piston and the second and third stage compressor pistons to the exhaust port diesel piston. The back face of the first stage compressor piston acts as the scavenge pump and normally supplies about four-fifths of the scavenge air, the remainder being delivered during the initial period of the first stage compression through a belt of valves located about one-third of the stroke length up the cylinder. The compressor differs from its principal rival, the Pescara machine, in not using a cushion cylinder (which provides a method of varying the output) ; the Junkers compressor relies solely on the energy stored in the clearance volumes of the compressor cylinders to give the requisite compression in the combustion cylinder. Water-cooled intercoolers and a final aftercooler reduce the air temperature after each compression. The water used for this purpose also circulates through the compressor and diesel cylinder jackets during its single-flow passage through the unit. With the exception of the fourth stage, the compressor cylinders are only partially jacketed. A pressure maintenance valve and a relief valve are situated in the compressed-air line between aftercooler and air receiver. The pressure maintenance valve may be set to control the delivery pressure at any value within the range 2000 lb to 3000 lb per square inch, while the relief valve opens, thus cutting off the fuel supply, before the pressure in the line reaches a dangerous level.

The motion of the piston groups is synchronised by the two pairs of racks to which they are connected. The racks engage with a 3in diameter pinion, the bearings of which are located diametrically opposite each other in the centre section. One of the pinion shafts drives the fuel pump, while the second (on the other side of the casing) drives a swashplate type of lubrication pump, which feeds ten lubrication points, and also provides a drive for the water coolant pump. The fuel system consists of a Bosch type jerk pump and an open injection nozzle, located in the unit centre section. The fuel rate is controlled by a rack adjustment of the fuel pump plunger helix position which regulates the effective delivery stroke. The plunger is of the helix type which ends injection at the same point for all loads, but which advances the start of injection with increasing load. The air delivery is controlled by the fuel injected per cycle. All compressor and scavenge pump inlet and exhaust valves, of which there are a considerable number, are 0·55in in diameter with spring-loaded pressure-actuated discs. Starting is achieved by first locking the pistons in the outer dead position, and then admitting compressed air (at about 500 lb per square inch) to the compressor stages. When the first-stage pressure reaches a certain value (between 40 lb and 50 lb per square inch) the latching gear is tripped and the pistons are flung together. The compressor differs from the conventional reciprocating engine in reaching its equilibrium running frequency almost instantaneously. The phrase "revolutions per minute," is, of course, inappropriate in the case of the free-piston compressor.

Instrumentation

The fuel consumption of the unit is measured by means of the well-known B.I.C.E.R.A. flow meter, which is a compact form of weighing machine, and so arranged that the pressure acting on the fuel system remains constant over the measuring period. The single intake inspires a pulsating flow of air, some of which is delivered after compression to a receiver, while the remainder is used for scavenging. The total mass flow is measured by a plate orifice of 2in diameter, together with an inclined water manometer, prepared in accordance with British Standard Specification No. 1042 of 1943 ; this is used in conjunction with an airbox of capacity 12·7 cubic feet, calculated in accordance with Kastner's* recommendations, which is interposed between orifice and intake and serves as a capacity to smooth out the pulsations.

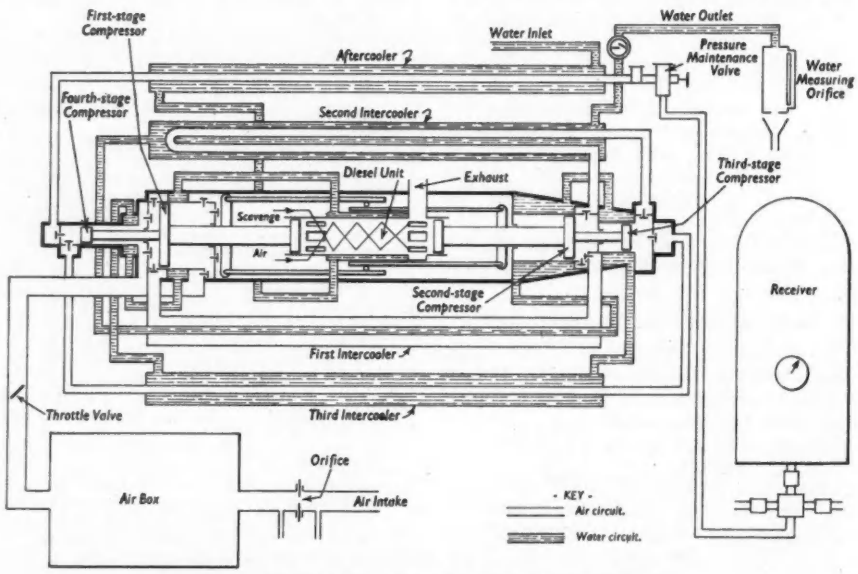


Fig. 1—Schematic layout of Junkers free-piston compressor

The rate of air delivery to the receiver, which has a capacity of 25·3 cubic feet, is obtained by observing the initial receiver pressure and temperature, running a test at given conditions for a given time and immediately afterwards closing the delivery valve to the receiver. The final pressure is noted only when it has become constant, i.e. when the receiver temperature is again the same as the ambient temperature. This process, though somewhat lengthy, avoids the difficulty of measuring the temperature of a large volume of highly compressed air. Ignoring leakage, the scavenge air flow is the difference between the air inspired and the air delivered to the receiver. Provision is made for progressive throttling of the air

* Kastner, L. J., 1948, *Proc. Instn. Mech. Engineers*. London. Vol. 157, "An Investigation of the Airbox Method of Measuring the Air Consumption of Internal Combustion Engines."

intake to the unit by inserting a butterfly valve in the suction line between the airbox and the main intake.

The stubshaft extending from the fuel pump is fitted with a pointer which traverses a scale calibrated to give the distance of the pistons from the centre line at any instant. The pointer movement is difficult to follow by eye when the unit is running and the length of stroke is best obtained by feeling the extreme positions of the pointer with a thin rod. The operating frequency is obtained by fitting a cam to the stubshaft used for driving the coolant pump. A spring-loaded follower provides the oscillatory motion necessary to drive a ratchet type of counter. Thermometers are fitted in pockets throughout the coolant circuit, which also incorporates a final discharge orifice, so that the rate of water flow and, hence, the rate of heat extraction, may be obtained for each compressor stage, the diesel cylinder jacket, the three intercoolers and the final aftercooler. Tappings from the scavenge air receiver and the diesel exhaust pipe are taken to manometers so that approximate values of scavenge and exhaust pressures can be obtained. A sampling tube, fitted in the exhaust line, makes it possible to carry out an exhaust gas analysis.

Performance

The experimental tests show that the maximum range of operating frequencies, from 775 to 890 cycles per minute, is quite small compared with the speed range of conventional reciprocating engines. The frequency is almost independent of fuel rate (i.e. load), increasing only slightly, by no more than 25 cycles per minute, at light load. Fig. 2 shows the dependency of frequency

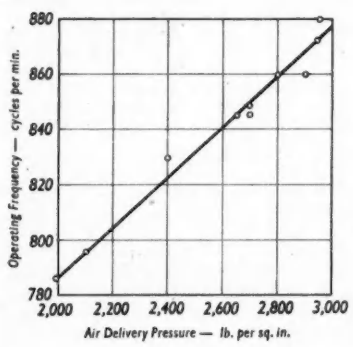


Fig. 2

on final discharge pressure over the range from 2000 lb to 3000 lb per square inch, the relationship being roughly linear. This is in accordance with the spring mass nature of the free-piston system. Lower discharge pressures correspond to softer air springs in the clearance spaces, and, therefore, to lower natural operating frequencies. At light loads, the softer springs of the engine cylinder gases are more than compensated by the shorter piston stroke; this results in a slight increase in frequency. Throttling of the compressor causes a reduction in frequency, probably because of the increased compressor pumping work.

In Fig. 3, the stroke length is plotted against fuel rate for three values of the final discharge pressure. At any given value, an increase in fuel rate means that more energy is released for the outward stroke. Fig. 3 confirms that the stroke length is thereby increased. For a given fuel rate, on the other hand, an increase in compressor delivery pressure causes a reduction in stroke length, because more work must be done per pound of air delivered. The tests show that the stroke can be varied between extreme limits of 8·86in and 8·00in. The compressor will not operate at shorter strokes because there is then insufficient opening of the ports for adequate scavenging of the diesel cylinder. Throttling of the

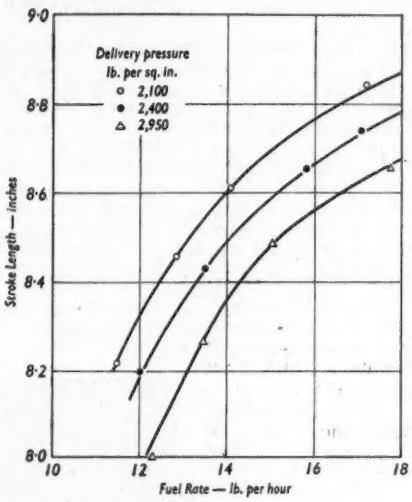


Fig. 3

intake air and variation in the coolant flow rate have no significant effect on the stroke length.

At a maximum fuel rate of about 17·75 lb per hour, the free air inspired by the unit, based on S.T.P. conditions, varies only from 209 to 214 cubic feet per minute as the delivery pressure is increased from 2100 lb per square inch to 2950 lb per square inch. This is because the resulting increased operating frequency almost compensates for the shorter strokes. At reduced load the inspired air is less because, of course, the stroke length is also reduced. The compressor volumetric efficiency (based on the ratio of volume of free air inspired per cycle to the swept volume of the first stage compressor cylinder and scavenge pump) is reduced with shorter strokes and higher delivery pressures. A short stroke leaves a large clearance space in the compressor cylinders, and a high discharge pressure means that the clearance air occupies a large volume when expanded. The volumetric efficiency of free-piston compressors tends to be lower than that of conventional reciprocating machines because of the larger clearance spaces, and, in the present case, lies in the range from 48 to 66 per cent.

The free air delivered increases with piston stroke and fuel rate. At the rated delivery pressure of 2950 lb per square inch, the free air delivered rises from 42 cubic feet per minute to 60 cubic feet per minute as the fuel rate is increased from 12·5 lb per hour to 17·75 lb per hour. Below 12·5 lb per hour the unit does not function owing to incomplete opening of the diesel scavange ports. The air delivery is increased to 73 cubic feet per minute at maximum fuel rate by reducing the delivery pressure to 2100 lb per square inch. The lower operating frequency is thus more than compensated by increased stroke length, and there is an improvement in volumetric efficiency. An increase of up to 3 per cent in free air delivered at all loads is brought about by raising the coolant flow from 68·5 lb per minute to 76·5 lb per minute, so as to improve the heat transfer and thus to increase the air density. The range of operation does, however, remain rather narrow. The economy of the unit as a whole may be gauged from Fig. 4, in which specific air delivery (free air delivered per pound of fuel) is shown against fuel rate in pounds per hour for the whole range of delivery pressures. Maximum economy corresponds to 13·5 lb per hour of fuel at 2100 lb per square inch, increasing to 14·5 lb per hour at 2950 lb per square inch delivery pressure. This increase in the condition for maximum economy is probably due to the increase in operating frequency with discharge pressure, because the fuel injected per cycle is the same in both cases.

Between 2 lb and 2·5 lb of scavenge air are required for each pound of compressed air delivered to the receiver. Only about 1·5 lb of air are actually involved in combustion, the remainder being used for cooling and complete purging of the power cylinder. The engine scavenge pressure ranges between 1·5 lb per square inch and 2·7 lb per square inch (gauge). The Junkers compressor is not hampered so much as a conventional compressor under throttled conditions, and for this reason was widely used in submarines by the German navy in the last war. Thus if the total air inspired is reduced by 30 per cent, the fall in compressed air delivered is only 14 per cent, but the volume of scavenge air is reduced by nearly 34 per cent, the scavenge pressure being correspondingly reduced. The volume compression ratio is almost independent of fuel rate unless the intake is heavily throttled, when it varies inversely with load, owing to the increased pumping work. Otherwise the compression ratio increases with delivery pressure, from about 20 at 2100 lb per square inch to more

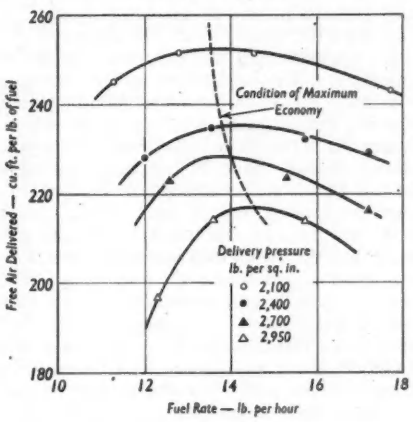


Fig. 4

than 30 at 2950 lb per square inch. This is a natural consequence of more energy being available for the return stroke.

The index of polytropic compression (and re-expansion) of the air in each compressor stage may be approximately assessed, knowing the heat transferred to the intercoolers and aftercooler and the air temperature following compression. At full load and maximum air delivery the estimated indices are 1·30, 1·31, 1·36, and 1·26 for stages 1, 2, 3 and 4 respectively. The lower index for stage 4 is attributed to the complete water-jacket and consequent better cooling. Fig. 5 shows that the air horsepower, calculated from the above compression indices, increases almost linearly with fuel rate, but diminishes with increasing delivery pressure. At full load the air horsepower is 27·8 at 2100 lb per square inch, falling to 25·6 h.p. at 2950 lb per square inch. This is probably mainly owing to the increased friction horsepower of the compressor. The overall thermal efficiency, based on air horsepower, is also shown in Fig. 5. As in Fig. 4, optimum overall efficiencies of 22·5 per cent and 21 per cent for discharge pressures of 2100 lb per square inch and 2950 lb per square inch respectively correspond to fuel rates of 13·5 lb and 14·5 lb per hour.

Since the air leaves the aftercooler at

approximately the temperature of the ambient air, the enthalpy per pound of air entering and leaving the compressor is about the same. The work done on the air and against friction, which per unit time is the brake horsepower

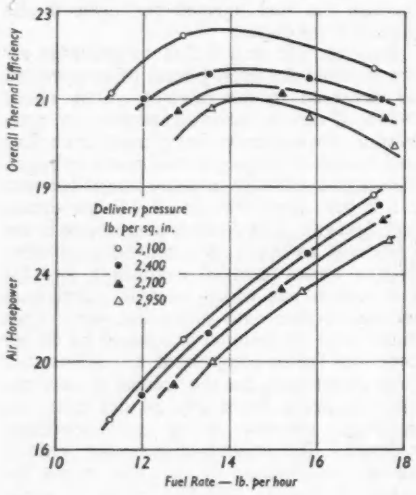


Fig. 5

of the diesel unit, all appears, therefore, as heat transferred to the cooling water. On this assumption the engine b.h.p. is 36·5 at full load decreasing to 25 h.p. at light load, and is substantially independent of delivery pressure. The optimum brake thermal efficiency is 32 per cent corresponding to a specific consumption of 0·43 lb per b.h.p. hour. At full load the brake thermal efficency diminishes to about 29 per cent. In view of the high compression ratio, and the uniflow scavenging this would appear rather low, but may be accounted for by the exhaust gas analyses which indicate incomplete combustion, especially at maximum load, due perhaps to unsatisfactory fuel injection or incorrect swirl. The measured air fuel ratio of the diesel unit is about 25 by weight at full load, rising to 40 at low load. Thus while the overall efficency of the Junkers compressor is good, and makes the unit competitive, the above breakdown of the test results suggests that there is still some room for improvement. It must also be conceded that the noise level of the compressor is high, even when elaborate arrangements are made to silence the intake and exhaust systems. The noise is thought to be partly mechanical and partly owing to the pressure fluctuations within the diesel and compressor cylinders.

ACKNOWLEDGMENTS

Acknowledgment is made to Professor A. F. Burstall, D.Sc., Ph.D., M.I.Mech.E., for his helpful advice during the preparation of this article, and for the provision of the necessary experimental facilities. The author also wishes to express his gratitude to the Admiralty Engineering Laboratory, West Drayton, for much material assistance in re-equipping the compressor. The experimental work described was carried out by Mr. R. Purchon, B.Sc., and Mr. T. A. Andvig, B.Sc.

SURFACE ROUGHNESS SPECIMENS.—We are informed by Rupert and Co., Ltd., Levenshulme, Manchester, that the company is now manufacturing cylindrical surface roughness specimens in accordance with B.S.S. 2634/1 : 1955. These specimens are available in a number of values and accuracies and each is ¼in diameter with a nominal length of 3¼in, having a ground reference surface 1½in long.

Direct Observation of Defects in Crystal Lattices

WE have received some notes summarising the interesting work on the direct study of crystal lattices recently completed by Dr. J. W. Menter, at the Tube Investments Research Laboratories, Hinxton Hall, Cambridge. Using an electron microscope, Dr. Menter has prepared electron micrographs showing defects in the crystal lattices of metal compounds at a magnification of 1,500,000 to 1. In this way visual confirmation has been obtained of the theory that the behaviour of solids under stress can be explained by the existence, in otherwise perfect crystal lattices, of defects such as dislocations. This work opens the way to interesting possibilities in the study of the physical properties—such as plastic strength, fatigue and creep—of metals.

It may be recalled that, soon after the discovery of X-rays, it was found that a crystal placed in the path of an X-ray beam would divide it into a number of "reflected" beams, the intensities and directions of which varied from one substance to another. From measurements on these reflected beams it can be deduced that the atoms of which the crystal is built are arranged in a very regular three-dimensional lattice, the distance between the atoms being between 10^{-7}cm and 10^{-8}cm. Such detail is beyond the scope of an ordinary optical microscope, which can resolve detail of dimensions about 10^{-4}cm or slightly less, at a magnification of perhaps 2000 times. The electron microscope is capable of resolving smaller details and one of the latest instruments originated and developed by Professor Ruska offers the possibility of obtaining photographs of crystals at a magnification of 1,500,000, showing detail of dimensions smaller than 10^{-7}cm.

Using one of the microscopes at Tube Investments Research Laboratories, Dr. J. W. Menter has succeeded in obtaining a direct image of the lattice of a crystal in which planes of molecules are spaced 10^{-7}cm apart. The distance between them, measured directly from the photographs, agrees closely with the value previously deduced by the indirect methods of X-ray diffraction.

The materials photographed are copper and platinum phthalocyanine,* whose molecules consist of a ring of organic material surrounding a central metal atom. Very thin crystals of these materials have been prepared and examined by directing the electron beam of the microscope through them. Under these conditions, in the orientation chosen, a particular set of crystal planes separated by 10^{-7}cm in copper phthalocyanine and $1{\cdot}2\times10^{-7}$cm in platinum phthalocyanine are seen edge on.

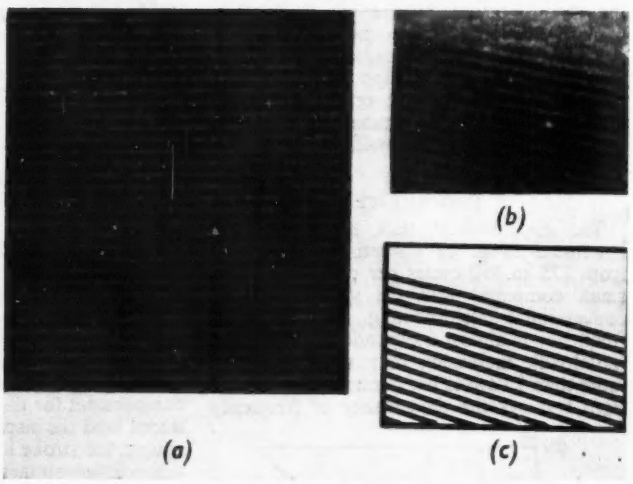
A photograph of a platinum phthalocyanine crystal obtained in this way is reproduced at (*a*), at a magnification of 1,500,000. Ideally, the image of the crystal lattice viewed in this orientation should consist of a rectangular array of dots, but this is not obtained because the spacing of the molecules along the lines in the photograph is too small to be distinguished even with this microscope. In some other crystals, where the distance between the planes of molecules in two directions is within the resolution limit of the microscope, arrays of dots have been seen.

* Copper phthalocyanine is otherwise known as Monastral Blue, the paint pigment.

The photograph, reproduced at (*b*), shows a dislocation in a platinum phthalocyanine crystal. The accompanying sketch (*c*), showing the nature of the dislocation more clearly, has been copied from the photograph.

The dislocation is formed where one of the planes of molecules terminates inside the crystal and its immediate neighbours continue to grow and join up again so that the spacing of the crystal planes at some distance from the dislocation is uniform. Near the dislocation, however, the lattice is considerably strained since the regular lattice structure is disturbed, exactly as had been suggested in Taylor's theory.

One of the main objects of contemporary research into the properties of solids is to try to understand the plastic, strength, fracture, fatigue and creep properties in terms of the movement of imperfections of the kind illustrated. Now that a means of seeing these imperfections directly has been demonstrated, it should be possible to study their movement under stress by recording cine-photographs.



(a) Part of crystal of platinum phthalocyanine showing planes of molecules $1{\cdot}2\times10^{-7}$ cm apart; (b) part of crystal of platinum phthalocyanine showing defect in structure defect; (c) copy from photograph above showing exact position of defect

North Scottish Navigator Chain

LAST week the complete coverage of the British Isles by the Decca Navigator System was effected when Mr. J. Henderson Stewart, M.P., Under Secretary of State for Scotland, formerly inaugurated the North Scottish chain. At the opening ceremony, which was attended by a large number of guests from interested companies, Mr. Stewart expressed the hope that the fishing fleets would make use of this new service. A further increase in coverage will be provided when the Swedish chain comes into operation. The new chain follows the pattern of others in having a master and three slave stations, the master station being at Kirkwall in the Orkneys and the red, green and purple slave stations being at the Butt of Lewis in the Outer Hebrides, at Lerwick in the Shetlands and at Peterhead, respectively. The coverage of the new chain extends well beyond the Faroes, a considerable distance into the Atlantic, and to the coast of Norway. Thus it provides a navigational fixing facility of great precision over a large area of sea which should increase the safety of fishing boats using these waters and should also be of economic value. In addition the chain will be an aid to the navigation of shipping *en route* to Scandinavia and to aircraft navigating in remote areas of Scotland.

International Machine Tool Exhibition

No. III—(*Continued from page 774, June 29th*)

THE International Machine Tool Exhibition, which was opened at Olympia on June 22nd, and closes to-day, has once again proved to be one of the most interesting engineering exhibitions held in this country. The large number of visitors each day has included many buyers and machine users from this country and overseas, and we understand from many of the exhibitors that there is good reason to expect that substantial business will result from the inquiries with which they have dealt. In this article we continue our descriptions of some of the machines and equipment shown.

H. W. Kearns and Co., Ltd.

The new machines of interest on the stand of H. W. Kearns and Co., Ltd., Broadheath, near Manchester, are the "OB" model "Optimetric" horizontal toolroom boring machine and the No. "0" planer table machine fitted with a B.T.H. electronic co-ordinate setting system, as described in our issue of April 6th last. The new "OB" machine, illustrated in Fig. 73, has been developed as a result of the success of the small "Optimetric" machine, and the demand for one of larger capacity. As on the small machine, a Hilger and Watts optical system of co-ordinate setting is fitted, together with a number of design improvements.

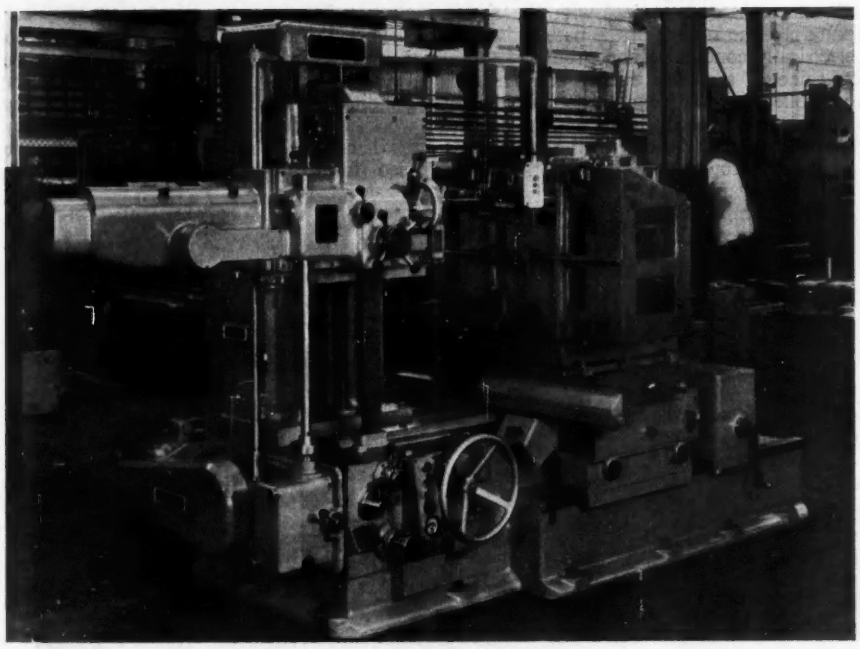


Fig. 73—3in spindle toolroom boring machine fitted with "Optimetric" setting system—Kearns

The new machine has a 3in diameter spindle, a vertical traverse of 2ft, a transverse travel of 27in, and its revolving table is 30in square. In order to reduce to a minimum the influence of temperature changes between the foundation and the machine, a special foundation grid is supplied, which permits air to circulate freely around and under the bed of the machine. The main bed is held to the grid at one end only and any changes of dimensions which take place due to temperature cause the bed to move as a whole and thus a possible cause of distortion is prevented.

The saddle which supports the main table is carried on a bed with a special channel, which, in addition to guiding and supporting the centre section of the saddle, houses the bed screw and shaft mechanism. The ends of the saddle are fitted with large-diameter rollers, which ride on the outer ways of the main bed. A revolving table on the main table is fitted with four hardened steel inserts, which, in conjunction with a hardened steel locating wedge, enable the revolving table to be set accurately in four positions at 90 deg. At the left-hand end of the main bed are the nine-speed main gearbox, the feed box and a distribution unit, each of which is a self-contained unit. Drive from the 5 h.p. main motor mounted at the back of the bed is transmitted to the gearbox by a plastic/chrome-leather belt, and a cushioned drive by a similar belt is provided between the main gearbox and the spindle slide. A change gear arrangement in the spindle slide gives eighteen spindle speeds from 15 to 750 r.p.m.

The spindle slide is balanced and the spindle sleeve, which is mounted on ball and roller bearings, is fitted with a special nitrided cast iron bush, through which the steel spindle slides. The spindle and sleeve always rotate together. A new departure in this machine is a spindle feed mechanism completely enclosed in a light alloy casting, an arrangement which gives full support to the spindle bearing and at the same time reduces the overhung weight. The firm's own design of feed system which is fitted gives two ranges of six feeds, one in cuts per inch and one in inches per minute. Both of these feed ranges apply to all the traverses on the machine.

Projection screens for the optical system of co-ordinate setting are provided for the vertical adjustments of the spindle slide and boring stay and the transverse movement of the table. In this system no end rods, gauges or dials are used, and the graduations on steel rules mounted in adjustable housings are projected on to large screens marked with vernier graduations. It is stated that settings can be made to 0·001in with an error not exceeding 0·00025in.

The No. "0" planer table machine fitted with B.T.H. electronic co-ordinate setting has independent feed motors with electro-magnetic clutches for operating the vertical feed of the spindle slide and the transverse movement of the main table.

On the operator's desk is a reader for the punched cards used to set the co-ordinate positions. A series of hand-setting dials also provided may be used as an alternative to the card reader. The control pendant hinged from the top of the main vertical column carries ten push buttons, which operate the main spindle motor and the automatic positioning to the vertical and transverse adjustment. Automatic hydraulic clamping holds the spindle slide, table and boring stay bearing in position on the completion of the automatic setting cycle.

Brooke Tool Manufacturing Company, Ltd.

Four models of unit heads are made by the Brooke Tool Manufacturing Company, Ltd., Greet, Birmingham, 11, for use on transfer or other types of special-purpose machines. Each model is made in three sizes with alternative strokes, feeds and speeds, and the range covers spindle motor drives from 1½ h.p. to 20 h.p. A typical head, "Model UH3," is shown in Fig. 74.

It is available with a 6 h.p., 1500 r.p.m., or a 7½ h.p., 3000 r.p.m. motor, and with a 12in, 17in or a 22in stroke. The motor is built into the body casting and drives the main spindle through vee belts and a worm and worm wheel. Speed changes are effected through the pulleys and two ranges are available—from 65 to 330 r.p.m. in the low range and 300 to 1500 r.p.m. in the high range. The spindle nose is arranged for the fitting of a multi-head driver, Morse taper adapter or other special tools.

Feed of the head is by a nut driving along a stationary lead screw and the feed gears are driven directly from the main spindle. Through pick-off gears, feeds from 0·001in to 0·020in per revolution can be obtained, and a separate motor gives rapid traverse at 130in per minute. The heads are designed for automatic cycle operation, which is

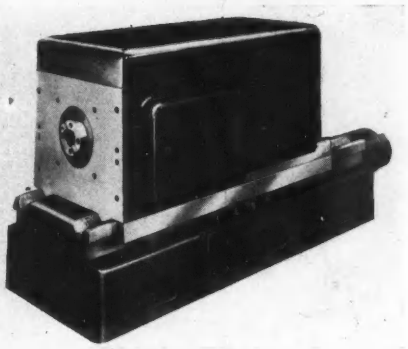


Fig. 74—Unit head for use on transfer and special purpose machines—Brooke Tool

controlled by dogs adjustable along a bar on the side of each head. These dogs operate limit switches which can be seen projecting up from the base in our illustration. When a head is used for counterboring a fixed depth stop is mounted at the front of the base, and a time delay switch allows the feed drive clutch to slip for a short period at the end of the stroke.

F. J. Edwards, Ltd.

A new design of swing-beam box-and-pan press brake, capable of exerting a force of up to 10 tons and of taking work up to 36in long, is included in the wide selection of sheet metal working machines of F. J. Edwards, Ltd., 359, Euston Road, London, N.W.1. The swinging top beam of this machine enables trunk sections formed round the beam to be withdrawn complete, and the angle-bending blade can be replaced by the segmental blade as shown in the accompanying illustration (Fig. 77).

This segmental blade is used when forming pans, boxes and trays, and it consists of detachable finger members which can be assembled at any point along the beam. These fingers can be used for forming boxes up to 6in deep and they are made in various widths for assembly into blades giving a total bending length of up to 36in. The respective widths of the fingers supplied are as follows : one of 1½in, one of 2in, one of 2½in, two of 3in, two of 4in, two of 5in, and one of 6in. The maximum gauge of material which can be handled is 14 gauge with a vee die opening ¾in wide.

The top beam, machined from steel plate, is 8in deep by 2in thick, and it swings out in double thrust bearings. The beam is locked in the operating position by a spring plunger and is adjustable up to 8in high by operation of a handle at the side, so that blades of various heights can be accommodated. For production angle-bending the narrow blade used is 2in deep, whilst for making open-topped boxes or trays the 10in deep segmental blade is used. The minimum size of a trunk section which can be formed is 8½in by 8½in. The length of stroke is 1in and with the stroke up, the maximum distance between the ram and the bed is 12in. The lower frame, which, with the deep bed, ties the side frames together, serves as a base in which there is enclosed the 1¾ h.p. motor drive. Power is transmitted through vee belts to a heavy flywheel gearing and a clutch ; and the machine can be set to run at up to forty strokes per minute. Work gauges at the front and the rear of the machine have an adjustment of 24in.

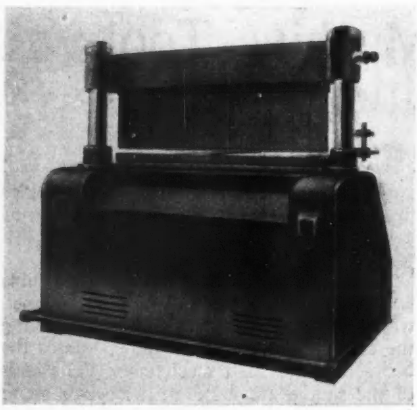


Fig. 77 — Motor-driven swing-beam press brake—Edwards

Buck and Hickman, Ltd.

The American machines demonstrated by Buck and Hickman, Ltd., Otterspool Way, Watford, Herts, include the interesting Pratt and Whitney " Valvetrace " milling machine shown in Fig. 75. This machine is designed for three-dimensional copying of work and uses a tracer equipment which makes no actual mechanical contact with the master pattern. The surface of the pattern is made electrically conductive and grounded to the machine ; and the tracing equipment is controlled by the maintenance of a short spark gap between the tracer and the pattern. The slightest variation in the spark gap produces a proportional change in the voltage across the gap. This change is amplified by electronic means and used to control the drives to the spindle quill and the longitudinal and transverse table motions.

For directional control the spindle quill is fitted with a specially designed magnetic clutch drive. In this drive a pair of magnetic clutches, rotating in opposite directions, engage armatures that are individually connected through pinions to a spindle rack. Motion is transmitted through these pinions when the control increases the torque of one magnet and decreases torque of the other, causing one to be driven and the other to slip. The slipping magnet never completely disengages and retains contact with the rack at all times. This opposed drive provides a high degree of sensitivity with continuously variable speed control, and eliminates backlash. The table and carriage are fitted with similar drives.

The spindle is driven by a 1 h.p. motor and has twelve speeds, from 310 to 10,800 r.p.m., its length of vertical travel being 3⅜in. The table has a working travel of 12in and a transverse movement of 9in at steplessly variable speeds up to 20in per minute. The knee has a vertical movement of 13in and the distance between the spindle housing and the table top is adjustable from 4in to 17in.

The group of Brown and Sharpe machines displayed includes that firm's British-built No. 00G automatic screw machine, a universal miller, a universal grinder and the face grinder illustrated in Fig. 76. This machine is designed to grind work faces up to 10in diameter and 3in thick when fitted with a magnetic chuck. Its work head rotates in a vertical plane, an arrangement claimed to give better quality surface finish to the work as the coolant supply washes all the grit away. Three work speeds of 150, 200 and 250 r.p.m., are available through stepped pulley drives, and the head can be swivelled up to 10 deg. on either side for grinding concave or convex work. The work head slide is adjusted longitudinally by a handwheel and has an automatic feed from 0·0001in to 0·003in at each

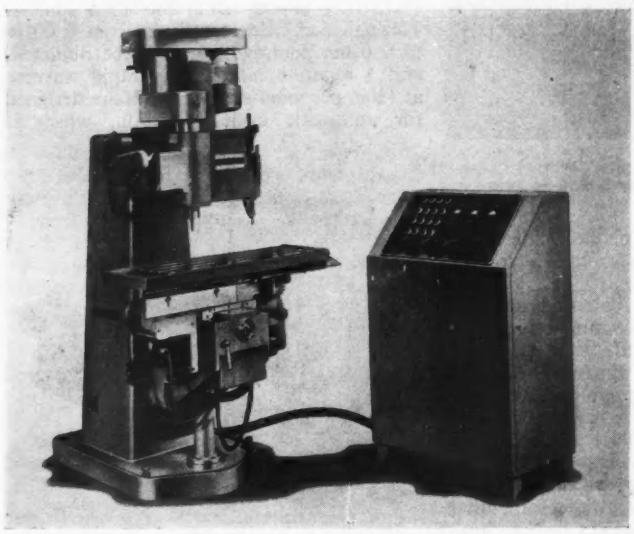


Fig. 75—" Valvetrace " milling machine with automatic tracer control—Buck and Hickman

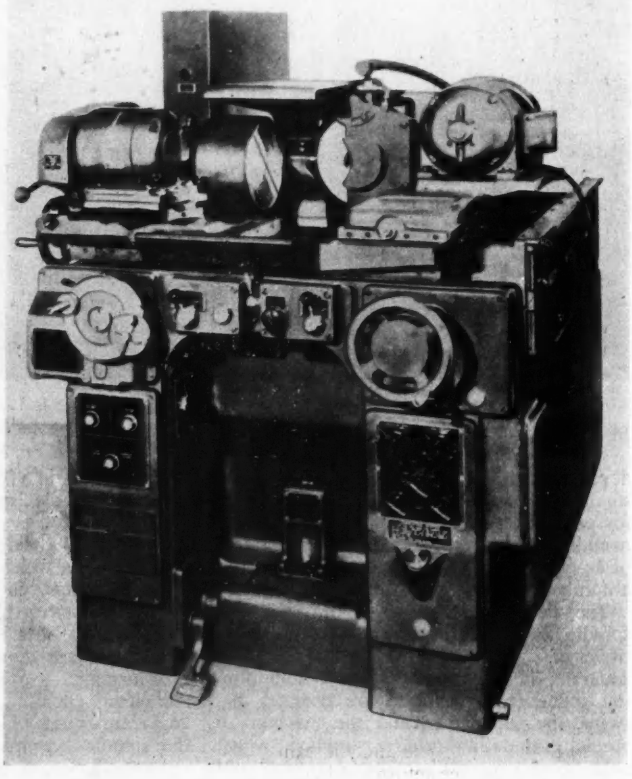


Fig. 76—Brown and Sharpe face grinding machine on which the work head rotates in a vertical plane—Buck and Hickman

reversal of the wheel slide or at the forward reversal only..

The wheel head is driven through pulleys by a 1½ h.p. motor, giving speeds of 1910, 2540 or 3640 r.p.m. to the wheel. The hydraulically-operated wheel head slide has cross feed rates from 3in to 150in per minute over its 8in length of traverse. A set of controls grouped at the front of the machine control all operations, and can be arranged to give either a semi-automatic working cycle or manual control.

John Lund, Ltd.

One of the three cylindrical grinding machines being exhibited by John Lund, Ltd., Eastham Works, Cross Hills, near Keighley, is a hydraulically-operated MPB 14/40 machine fitted with the firm's combined hydraulic tailstock and wheel truing device.

This form of tailstock (Fig. 78) increases the scope of the machine for plunge cut grinding and accelerates wheel dressing between operations. It consists of a base fixed to the machine table and a top slide which incorporates the tailstock centre and the cam follower slide, both slides being hydraulically-operated.

When operating as a tailstock the cam follower is retracted clear of the cam and the top slide traversed to engage the centre in the work. This traverse motion is spring operated, the hydraulic pressure being equalised on each side of the piston so that the job is held by spring and not hydraulic pressure. When operating as a truing device the work is removed from the centres and the machine table traversed to a stop set to ensure correct location of shoulders or faces. Subsequent movement of the control lever first engages cam and follower, oil pressure being maintained to hold the follower in contact with the cam, and then traverses the top slide. The follower slide carries the diamond used for dressing, and as the top slide traverses the follower is drawn along the "edge cam," and the diamond reproduces the cam form on the wheel. The cam can be readily changed and as the follower nose radius is only 0·032in diameter it allows a wide variety of forms to be reproduced. The dressing speed is steplessly variable between certain limits and the cam follower retracts before the return stroke starts.

One of the firm's double-ended fine boring machines is arranged for fine boring, facing, grooving and chamfering automobile steering control units. The component is mounted in a hand-operated two-station rotary indexing fixture having fixed locating pins and hand-operated spring compensating clamps. The machine table is electrically interlocked against movement when the rotary fixture is not in the boring position.

A single heavy-duty fine boring head at each end of the machine is equipped with boring bars and tools for the operations. The facing, grooving and chamfering operations are carried out by out-feeding the boring bars after completion of the bore. The operations are carried out on a semi-automatic cycle.

Selson Machine Tool Company, Ltd.

An interesting machine exhibited by the Selson Machine Tool Company, Ltd., Cunard Works, Chase Road, London, N.W.10, is the Cleveland 1⅜in single-spindle "Dialmatic" automatic screw machine shown in Fig. 80. In this machine turret feeds and spindle speeds are electronically controlled and are infinitely variable over their complete ranges.

The spindle is driven through gears by a 5 h.p., 1800 r.p.m. motor at steplessly variable speeds from 40 to 3200 r.p.m., and the speeds can be preset through dials and switches on a panel for the forward or reverse direction for each of the five tools in the turret head. If required, it is thus possible to set ten different spindle speeds for a machining cycle. The turret, which has five tool stations and a stroke of 5in, is indexed by a Geneva motor, and no cam changes are needed to adjust the feeds of the tools. An electrically operated feed drive enables the feed speeds to be preselected for both the forward and return motion of each tool by the setting of an appropriate dial. Each of the two cross slides has a travel of 4in and they are controlled by separate adjustable drums, their feed rates being a proportion of the turret feeds. An independent parting-off attachment mounted on the spindle head has a stroke of 1⅞in.

Another American machine on this stand is the Morey "50MA" airframe profiler and milling machine (Fig. 79), specially designed for machining non-ferrous aircraft components at high speeds, as well as large ferrous castings and forgings. This machine has a table 48in wide by 120in long and the

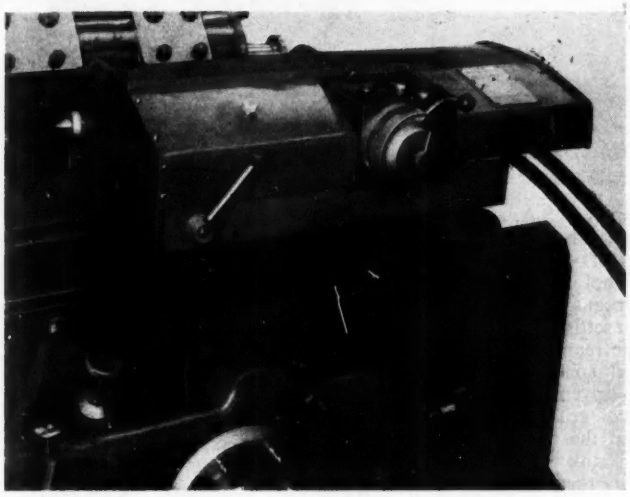


Fig. 78—Combined hydraulic tailstock and wheel truing equipment for cylindrical grinder—Lund

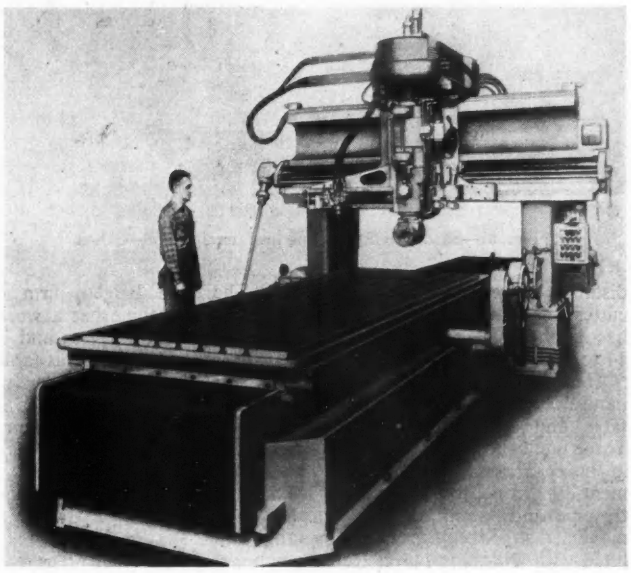


Fig. 79—Morey heavy duty profiling machine for large aircraft components—Selson

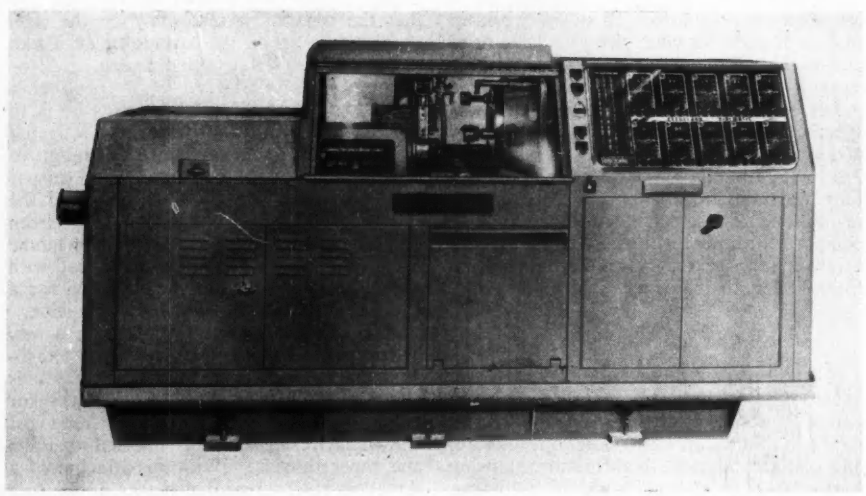


Fig. 80—"Dialmatic" automatic with electronically controlled feeds and speeds—Selson

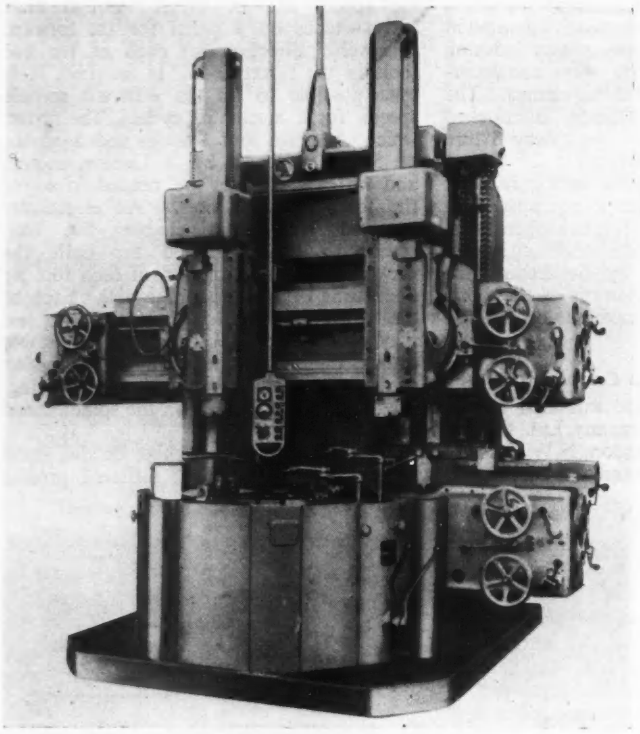


Fig. 81—Skoda vertical boring and turning mill—Selson

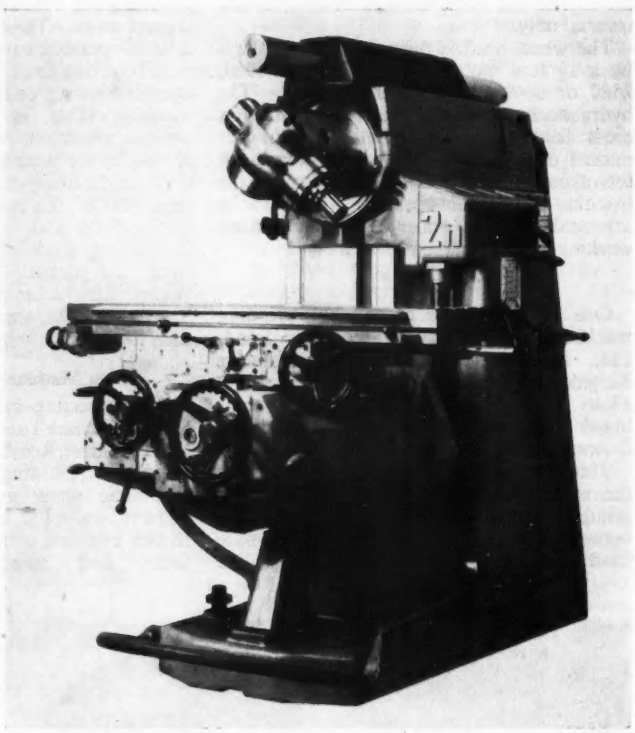


Fig. 82—Gambin horizontal milling machine—Cohen

distance between the columns is 60in. The cutter head, which has a traverse of 55in, has a range of eighteen spindle speeds from 44 to 4800 r.p.m.

This machine is basically designed for hand operation with a template on the work table and a tracer on the spindle head. Three handwheels are used during machining in this case, one for longitudinal table movement, a second for the spindle head cross traverse and the third for vertical spindle movements. Machines with long tables are fitted with hydraulic power feeds, which can be brought into use on long straight cutting work, the more intricate profiling being carried out by hand operation. The machine illustrated is equipped for automatic operation with a hydraulic tracer equipment controlling all movements.

The Skoda machines shown in this country for the first time include two lathes, a horizontal boring and milling machine and the vertical boring and turning mill, illustrated in Fig. 81. This heavy-duty machine has a 3ft 10½in diameter table and swings work up to 4ft 1in diameter when using the side head and 4ft 5in with the head lowered below table level.

The machine is driven through a four-speed gearbox by a variable-speed motor giving four ranges of table speeds from 3·5 to 150 r.p.m. and the heads have twenty-four feed rates from 0·0024in to 0·36in per revolution. The left-hand head feed box is equipped for taper turning and threading and using change gears twelve different tapers from 90 deg. to 168 deg. can be machined.

George Cohen, Sons and Co., Ltd.

A number of Continental machine tools new to the British market are to be seen upon one of the stands of George Cohen, Sons and Co., Ltd., Sunbeam Road, London, N.W.10, and, on a second stand, this firm is also showing a selection of sheet metal working equipment.

An interesting machine designed to sharpen tungsten carbide tipped tools is made by the Belgian firm of Imperia S.A. This machine has a work table with longitudinal hand traverse and means of vertical adjust ment. On this table the tool is mounted on a special holder with means of universal adjustment for the angular setting of the tool.

A rotary column at the rear of the table has four horizontal wheel spindles, spaced at 90 deg. intervals, each driven by its own motor. In the sequence of grinding a tool, a vitrified wheel is used on the first column station to grind the steel shank to the clearance angle. The column is then rotated 90 deg. to bring the second wheel spindle into the operative position. The diamond impregnated wheel on the second spindle is then used to grind the tip back to beyond the point of wear. The tip is then finally sharpened and polished by diamond impregnated wheels at the following two stations of the column. During the grinding operation the work table is reciprocated by hydraulic means and a flow of coolant is maintained from a sump in the base of the machine. So that the wheels cut separately on the steel shank and then on the carbide tip of a tool the vitrified wheel is tilted 2 deg. and the diamond wheels 1 deg.

Amongst the milling machines, there is to be seen a relatively new model of a Jaspar universal miller and an improved design of Gambin horizontal machine. The Jaspar machine has a 52in by 12in table and the eighteen spindle speeds available range from 31·5 to 1600 r.p.m. The Gambin machine (Fig. 82) has an adjustable milling head with various spindle settings, and its table has a working surface 47¼in long by 11 $\frac{13}{16}$in wide.

A Demoor lathe is exhibited with a new hydraulically-operated screw-cutting attachment fitted on the rear of the saddle. This attachment has an automatic cycle for repetition work, and it can be used for machining external and internal parallel and taper threads. With this attachment a thread is cut by repeated passes of the tool at a diminishing rate of in-feed, which is preset and automatically maintained.

Stuart Davis, Ltd.

The "Heligrind" spur gear grinding machine made by Stuart Davis, Ltd., Much Park Street, Coventry, is intended for grinding fine pitch spur gears on a mass production basis. It is designed to handle work up to 4in diameter, 3in long, from 16 to 64 D.P. The machine, to be seen in Fig. 83, operates on the generating principle of gear tooth development from the basic rack form, its wheel being formed as a single start spiral rib. The grinding process is continuous and it is stated that gear forms up to 20 D.P. can be ground economically from the solid.

The grinding wheel is mounted on a spindle carried in ball bearings on the head, and this spindle is driven through vee belts by a 2 h.p. 1430 r.p.m. motor in the base of the machine.

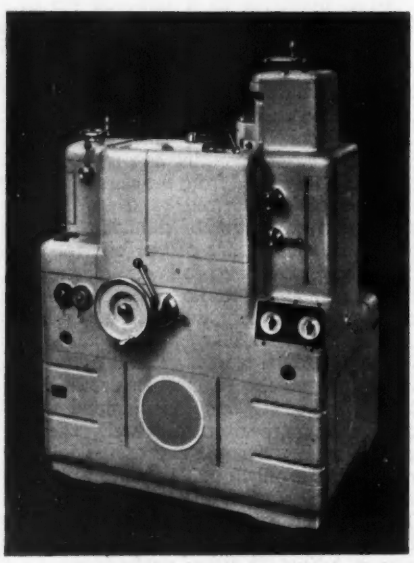


Fig. 83—"Heligrind" spur gear grinder for gears up to 5in diameter of 14 to 64 D.P.—Stuart Davis

Rapid withdrawal of the wheel from the work can be effected manually for setting purposes or automatically at the end of the grinding stroke. The wheel is formed by crushing, using a freely rotating grooved roller of the required pitch and form which is traversed in timed relation across the surface of the wheel. Pick-off gears are used to cover the ratios required, and an adjustable sine bar is incorporated in the mechanism to set the traverse ratios to the required accuracy.

The workpiece is mounted on a mandrel located between vertical centres and it is fed upwards through the wheel during grinding. Change gears used to interconnect the work and grinding wheel spindles provide a range of seven feeds from 0·0025in to 0·040in per revolution of the work to the work slide. A side cut control is incorporated for aligning precut work with the ribs on the grinding wheel.

An automatic universal horizontal press made by Fabrique John A. Chappuis S.A., of Switzerland, shown on this stand is illustrated in Fig. 84. This press has two horizontal rams, which can operate either in sequence to give a combined power of 25 to 30 tons, or at a displacement of 40 deg. for independent operation, when each has a capacity of 20 tons. A tool area of 18in by 9in is available on the table of the machine and each ram has a stroke of just under 2in. A crankshaft carried in large bronze bearings actuates the ram slides through two connecting-rods. Each slide is a hardened and ground steel block carried in cast iron vee-ways incorporating means of adjustment to take up wear. A 4 h.p. motor drives the flywheel of the press through vee belts and interchangeable pulleys giving three alternative crankshaft speeds of 80, 100 and 120 r.p.m. A reduction gear is interposed between the flywheel and the crankshaft, and a clutch built into the flywheel is controlled by a hand lever at the side of the machine.

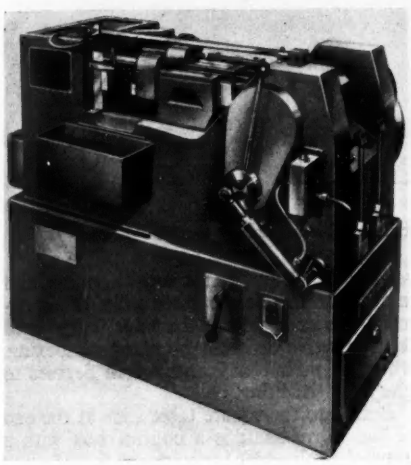


Fig. 84—Chappuis universal automatic press with two horizontal 20-ton rams—Stuart Davis

Grooved feed rollers at the side of the table can be used for strip up to 3⅜in wide and 0·004in to 0·118in thick, and up to 4⅜in at each working stroke of the press. An ejector mechanism is actuated by a cam on the crankshaft between the two connecting-rods, and, if required, it can be used as an additional forming or piercing element. A range of standard tool blocks are available for both single and double ram working.

A Reinecker automatic internal grinder exhibited has a nominal capacity of 2in diameter by 4in wide with a chucking capacity of 6½in diameter. The machine can be supplied with grinding spindle running at up to 60,000 r.p.m., and four work speeds from 320 to 900 r.p.m. are available. It is designed for a fully automatic work cycle and all the movements are hydraulically operated. A universal relieving lathe made by the same firm has 11in high centres and takes work up to 40in long. With sixteen spindle speeds from 1·5 to 210 r.p.m. this machine has a range of reliefs from 2 to 40, and it is provided with a grinding head for the production of ground form relieving cutters.

Thomas White and Sons, Ltd.

The woodworking equipment of Thomas White and Sons, Ltd., Paisley, includes an automatic double spindle shaper and a redesigned planing and moulding machine. The double-spindle shaper is similar to a hand-fed spindle moulder or shaper, but is fitted with a power-operated jig feed attachment, and the operator can load one jig whilst the other is in use.

As can be seen from Fig. 85, the machine comprises essentially a heavy single spindle moulder with a special table, feed gear and a pneumatic pressure system for automatic production of repetition parts requiring edge finishing.

The stand has precision slides in which the cutter head is carried, and the spindle is driven by endless belt from a 4 h.p. totally-enclosed fan-cooled motor forming an integral part of the cutter head. Two standard spindle speeds of 5600 and 7200 r.p.m. are provided by two-step cone pulleys. For the heavy cutting duties often called for a top steady bearing is fitted on a rigid column fixed to the table. The complete feed, pneumatic pressure, top support bearing and vertical hold-down are mounted on the table as a single unit. The jig carrying the workpiece is rotated past the cutter block by a chain wheel, engaging a special roller chain conforming to the contour of the jig template, which in turn is pressed against a rotating guide collar. Both the guide collar and the chain wheel are concentrically mounted in a bearing fitted into a machined recess in the table. Drive to the chain wheel and guide collar is by roller chain from a worm gear reduction unit, driven by vee-belt and pulleys from a ½ h.p. motor ; a stepless feed range from 11ft to 35ft per minute is obtainable. The jig is held in close contact with the guide roller by a pneumatic cylinder, actuating pressure rollers carried on a slide bar which is guided in a machined slot in the table. Either double or single rollers, depending on size and form of jig, can be used. A top pressure head carried on the vertical column provides adequate hold-down pressure on the workpiece close to the cutting point.

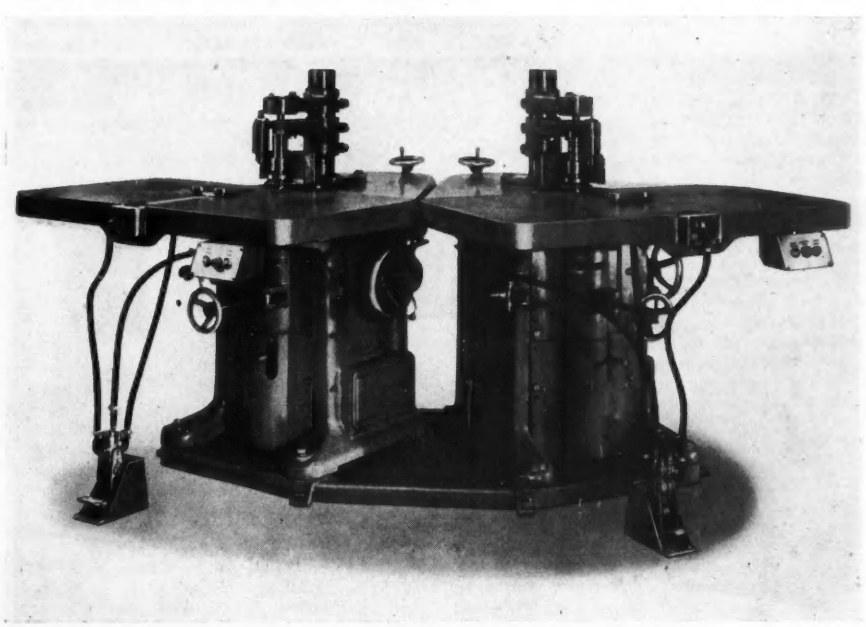


Fig. 85—Double-spindle automatic shaper with power-operated jig feed attachment—White

Butler Machine Tool Company, Ltd.

A number of improvements are incorporated in the hydraulic open-side planing machine (Fig. 86) which is one of the exhibits of interest on the stand of the Butler Machine Tool Company, Ltd., Miles Thorn, Halifax. This machine, with a working stroke 6ft long over a width of 28in, has a 6ft by 2ft 6in table, carrying work up to 30in high under the cross slide.

Its principal difference from previous machines of similar capacity made by the firm is that the drive is by a self-contained unit mounted alongside the machine. This drive consists of a flange-mounted 15 h.p. motor driving a Vickers duplex pump, which is mounted in the bottom half of the unit, forming an oil reservoir for the hydraulic system. The top half of the drive assembly cabinet contains all the operating valve gear, with solenoid operation to the pilot valves of the main table and feed reverse valves. These valves are secured to a " sandwich " plate into which is machined the majority of the piping system. Only four pipes are taken from the control unit to the machine itself, two for the table cylinder and two for the feed cylinder.

On the front of the control panel are two flow control valves, giving independent speed control for both the cutting and return strokes, together with a single lever which selects the high or low speed range. A built-in automatic electric control gear operates the starting and stopping of the main motor, the reversing of the table and the elevating of the cross slide.

The table driving cylinder is of sufficient length to give a 6ft stroke at any speed, and it is reversed by adjustable dogs in the tee slot in the front of the table. The dogs

operate a simple electric switch built into a control box at the front of the bed. This box also incorporates a hand-operated stroke reversing knob and start, stop, inch cut and inch return buttons which operate the solenoids on the main pilot reverse valve. The cutting speeds in the low range are 20ft to 60ft per minute and in the high range 68ft to 120ft per minute, the return speeds being from 36ft to 136ft per minute.

The feed is operated from a constant-throw feed cylinder connected to a vertical splined shaft which actuates separate independent feed boxes on the cross slide and side tool-box. The required direction of feed is selected by mechanical clutches and ten feed rates, from 0·02in to 0·20in per stroke, are available.

The cross slide, which is locked in position by two levers at the front, is elevated and lowered by an electric motor controlled from a lever on the control bracket attached to the side of the bed. Both tool-boxes are of twin vee design and have four locking bolts for securing the swivel slide to the down slide. The cross slide tool-box is fitted with a new design of vertical feed screw with the two nuts held in a unit attached to the top of the down slide so that the adjustable nut can be moved at any time. This nut is held to the down slide by a removable plug and it is possible to use this tool-box for copy planing without any mechanical alteration to the tool-box itself. Tool relieving is operated by a hydraulic cylinder behind each clapper box.

A 16in precision tool-room slotter (Fig. 87) of new design is stated to be probably the only machine of its kind which has been primarily designed to combine a large capacity with tool-room precision. This machine has six speeds and fifteen to eighty cycles a minute, the stroke being adjustable between 2in and 16in. The horizontal distance from the ram face to the frame is 32in and the maximum distance under the ram is 32in. The 4ft diameter table is mounted on slides given a 36in longitudinal and a 36in transverse travel. The drive is from a 5 h.p. motor in the base of the machine and connected directly to a six-speed gearbox, the six-position gate lever for which is located at the front of the machine. From this gearbox the drive is taken through a single helical pinion and stroke wheel to a slotted link, which incorporates the ram balance weight, and thence through a connecting link to the ram. The ram can be tilted forwards up to 7½ deg and carries a relieving tool-box which accommodates tools or tool bars in the horizontal or vertical position and which can be adjusted round the ram end to any angular setting.

The machine has a built-in automatic contactor gear and the ram is controlled from a pendant push button station, giving start, stop, inch forward and inch return controls to the ram. The length of stroke can be adjusted with the ram in motion or at rest, and the feed operating gear can also be adjusted at any time.

A vertical feed shaft is connected to a gearbox attached to the base of the machine and the power traverse from a flange-mounted motor is also taken through this gearbox to a common splined shaft. A second splined shaft carries the control lever used to select feed or power traverse. The feed and power traverse driving shaft and the control shaft are connected to the control box mounted at the end of the saddle. Two vertical levers on this unit control box can also be used to select feed or power traverse, and also the direction of feed. When power traverse is mechanically selected it is applied from a button on the pendant control, the movement continuing so long as the button is depressed. When the levers have been positioned the required feed is finally applied by turning either one of three control knobs on top of the control box, hand adjustment being provided in each direction through handwheels with adjustable micrometer collars.

A horizontal lever on the feed box operates the plunger indexing mechanism under the table and when the plunger is engaged a mechanical interlock makes it impossible to operate the circular feed. The 4ft diameter table can be locked to the square slide by levers at the front and back which operate bolts running in a tee slot machined on the underside of the table. The table worm and worm wheel run permanently in mesh and in addition to this accurate means of adjustment, the underside of the table is jig-bored to give twelve divisions by plunger indexing, whilst its perimeter is indexed in degrees to give a rough setting.

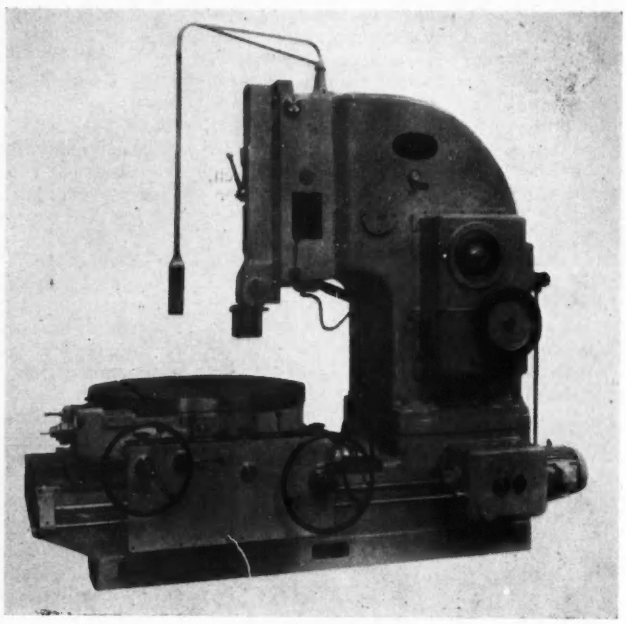


Fig. 87—16in precision tool-room slotting machine—Butler

Built into the square table slide at the end of the worm shaft is a control box with a knurled knob which is positioned for selecting circular feed, dividing head operation or neutral. When this control is in the circular feed or neutral position the worm shaft is directly controlled from the square shaft end without any intermediate gearing. When the control knob is turned to the dividing head position the circular feed is automatically disengaged and the dividing plate locked in position, two knurled knobs providing a fine adjustment to the dividing plate and a lock when it has been positioned.

One of the firm's 26in "Super" shaping machines is fitted with a new hydraulic copying equipment. A bracket on the side of the body carries a tracer head mounted on a slide which gives 6in of horizontal adjustment and 4in of vertical adjustment, while the stylus itself when in operation has 4in of vertical travel. The template is carried on an angle bracket attached to the side of the table, and when the machine is used for copying the standard horizontal feed is engaged and this traverses the work past the tool and the template across the stylus.

Geared up to the stroke wheel are two superimposed cams which can be adjusted in relation to one another and they operate a hydraulic valve which at the end of the cut stroke causes the table to retract from the work, providing an automatic tool relief, and at the end of the return stroke the table is returned to the working position.

(*To be continued*)

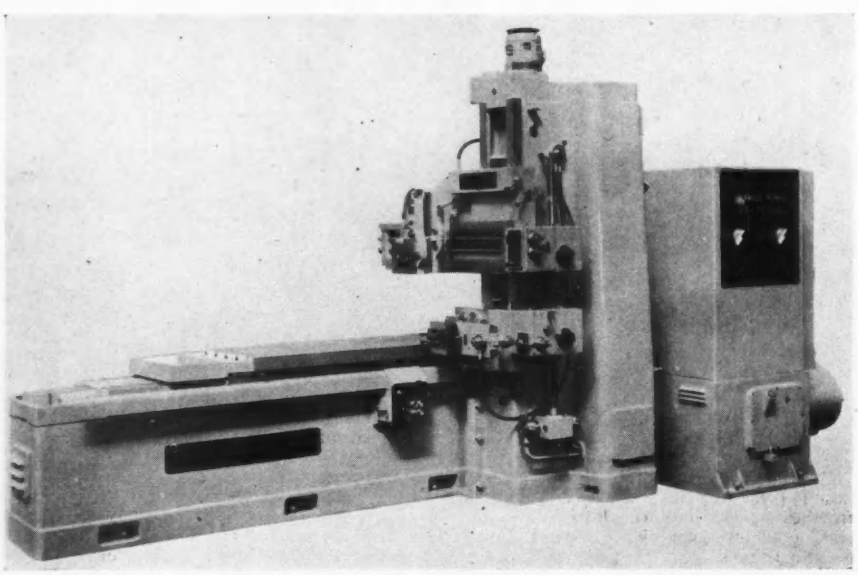


Fig. 86—Hydraulic open-side planing machine with separate self-contained drive—Butler

Fifth World Power Conference

No. III—(*Concluded from page* 751 *June 29th*)

Our review of the Fifth World Power Conference, which was held in Vienna from June 17th to 23rd, concludes this week with notes on Divisions III, IV *and* V *of the Conference. Hydro-electric power, nuclear power and "other sources" of energy and their utilisation are discussed in concluding our description of Division* III, *and we go on to discuss the purification of waste products* (*Division* IV) *and international co-operation* (*Division* V) *in energy usage.*

HYDRO-ELECTRIC power comprises only about 2 per cent of the present-day gross world production of energy.* The interest shown in section "H" of the conference was, however, far greater than would be inferred from this modest proportion. This was due, we would suggest, to rapid progress in a technology which, compared, for example, with coal mining, concentrates attention on a relatively costly initial development, often involving spectacular engineering achievements, with only minor "running costs" afterwards. Furthermore, many countries of the world are now basing ambitious development programmes to a large extent on the exploitation of water resources; benefits in irrigation, flood control and so on, are obtained, as well as in electricity generation.

The general reporter for sections "H_1" and "H_2" (Professor Grzywienski) pointed out that several aspects of his subject—relating more especially to civil engineering—had been dealt with quite recently at other international congresses, namely, the Paris congress on large dams in 1955, the soil mechanics congress at Zurich in 1954, and the hydraulic research congress at Delft in 1955. Nevertheless, progress in hydro-electric theory and design has been such that a great deal of new material was contained in the proceedings at Vienna.

Vast schemes for the control and utilisation of the rivers of large Continental countries described at the conference can be exemplified by quoting from speakers from the U.S.S.R. and China. The Kuibyshev power station on the Volga River (which has been briefly described in this journal) went into operation with its first generating sets this spring, and the Bratsk station, which is larger still and will have 200MW turbo-generator sets, is under construction. An unusual scheme, in which loss of water by evaporation was a critical problem, was described by a Russian speaker, Georg Ter Akopon. He referred to proposals for utilising the Sewan Lake in Eastern Siberia; this large natural lake is nearly 2000m above sea level. The proposed works envisage lowering the lake surface by 50m, and hence reducing its surface area appreciably. The scheme would be in two phases: (*a*) the emptying phase, which would take about fifty years; and (*b*) operation under a new hydrological régime with the lake at its new level. The run-off in the second phase, it was stated, would be seven times that of the first phase.

Several speakers from China referred to plans for developing that country's rivers, and principally to proposals for multi-purpose control of the Yellow River by a series of forty-six dams. The first two dams of this scheme would each have power generating capacities of 1000MW. The site which it was intended to develop first was at Sanmen Gorge; the dam here would be a key flood control structure and would have a height of about 90m.

There have been so many proposals put forward over the past few years for vast hydro-electric schemes in various parts of the world that we were particularly interested to hear the contribution made by Professor Thirring, of Austria, to the discussion in section "H." Professor Thirring referred to what he considered to be the largest concentration of potential hydro-electric power anywhere in the world. This was at a site in Tibet. The Brahmaputra River rises in Tibet, where it is known as the Tsangpo in its upper reaches, and then as the Dihang. Just before it crosses the frontier between Tibet and Assam the river follows a U-shaped course; by driving a tunnel about 10 miles in length across this loop a head of about 7000ft would be obtained; approximate estimates of the capabilities of the scheme are:

	Upper estimate	Lower estimate
River flow, km³ annually	77	34
Installed capacity, MW	38,000	17,000
Annual output, kWh × 10⁶	330,000	150,000

Professor Thirring considered that the site offered an ideal opportunity for joint development by Tibet, China, India and Pakistan; it would not only supply local power requirements over a wide area, he said, but also provide sufficient power to refine more aluminium than the present world production. It appears that a storage reservoir could be built on the Tsangpo with a dam of comparatively modest size. Huang Yu-hsien, who spoke later, said that Chinese engineers had already made a start on detailed study of the site. As a comparison with the figures just quoted, almost 74,000 million kWh were generated in the year ended March, 1955, by British power stations concerned with public electricity supply, and the corresponding installed capacity was about 20,000MW.

Pumped Storage.—A trend much in evidence at the congress was towards greater use of pumped storage for peak-load generation. One of the two British papers in section "H" was on this subject; the advent of base-load nuclear generation gives an added incentive for the development of pumped storage schemes, and the economics of pumped storage under British conditions was examined by Messrs. Fulton, Haldane and Mountain (227H/38). The Festiniog scheme in North Wales will be the first of such schemes to be developed by the C.E.A.; 300MW of pumping and generating plant, in four sets, is envisaged for this scheme, with reservoir capacity sufficient for four hours' generation daily, at maximum output. Four further schemes, totalling 750MW, in the Pennines and North Wales, are considered to be technically and economically feasible. In Scotland, the Balmaha and Cruachan proposals, each of 360MW, would provide pumped storage facilities in addition to some purely hydro-electric capabilities, and pumping plant could be superimposed on the Loch Sloy scheme.

Other papers on pumped storage included a description of a scheme in the Our valley in Luxemburg (44H8), and of Austrian pumped storage at Glockner-Kaprun (107H19) and on the river Ill (115H23).

Improvements in Water Turbines.—Descriptions of water turbines of improved performance were much in evidence in the papers of section "H." In particular, the Kaplan turbine has received the attention of designers in several countries, to make it suitable for higher heads. The general reporter noted that the highest efficiencies of turbines had again risen, and average figures were now 93 per cent for Kaplan turbines, 92 per cent for Francis turbines, and 91 per cent for Pelton wheels.

Very large Kaplan turbines are in use at the Kuibyshev power station. The runner of each of these machines is 11m in diameter, and the average head and flow 19m and 675 cumecs respectively, giving an average output of 108MW. When the head is higher, however, 126MW can be obtained from each machine. The load on the thrust bearing of each machine is 3400 tons. A Kaplan turbine with a head of 208ft has been commissioned at the Barcis power station (H42). In Czechoslovakia, two Kaplan machines for a head of 183ft have recently been put into service, and heads of 240ft are envisaged for future Kaplan machines (138H/24).

German proposals include putting a Kaplan turbine in the upstream part of the pier of a barrage, so that a radial inflow of water could be achieved while constructing only a small part of the spiral casing normally required. This suggestion was made by Dr. Press, who also gave details of some unusual dam designs. The German "tube" turbine set (it is very similar to the French "bulb generator" sets) has also been developed further (217H/34), the new design consisting of a Kaplan turbine with a generator lying downstream of it, almost horizontally, and driven through a speed-increasing planetary gear.

We conclude our review of this section of the congress with an abstract from the paper (224H/37) by Mr. Braikevitch, chief hydraulic engineer of the English Electric Company, describing a new development of some importance in hydraulic machinery, a "feathering" Francis turbine, which is reversible for use as a pump.

Studies made to develop a movable vane turbine for considerably higher pressures, he writes, indicated that, with the conventional axial flow arrangement, the runner hub would become so large and the vane so narrow as to result in an appreciable loss in efficiency. Accordingly, a logical step was the reversion to the mixed flow principle of the Francis turbine leading to the adoption of a Francis runner with movable vanes. This runner was developed by Mr. P. Deriaz. The axes of the vanes, instead of being at right angles to the turbine shaft centre line, are inclined to it at an angle and once this principle is adopted the hydraulic limitation of the conventional movable vane turbine as regards high heads is overcome. A laboratory model of such a runner for about 300ft head, surrounded by a conventional gate apparatus, gave the flat efficiency curve and the overload capacity associated hitherto only with the Kaplan turbine.

Meantime in Canada the Hydro-Electric Power Commission of Ontario was studying the possibility of applying a pumped storage scheme to ensure the most effective use over twenty-four hours of the water available at Niagara under treaty rights. Substantially more water can be drawn from the Niagara River during the night (when the scenic effect of the Falls is less important) than during the daytime, when the power demands are greatest. The proposal was to pump surplus water during the night into an artificial reservoir constructed above the power canal feeding the Sir Adam Beck power stations (see THE ENGINEER, October 1, 1954, page 451). The head between reservoir and power canal was about 55ft, rising to 90ft when the reservoir was filled. The proposed capacity of the reversible pump-turbine installation was of the order of 280,000 b.h.p.

Just as a 200ft head is nearing the upper limit for a Kaplan turbine, so 30ft is the limit for an axial flow pump. The limit for the pump is lower because energy is being imparted to the water and the centrifugal component of a mixed flow impeller is required in order to generate the head. Consequently the conventional approach to the problem of the reversible pump turbines for Niagara is a Francis runner. This would have to be surrounded by the usual gate apparatus to make the quantitative regulation of the turbine possible. When pumping was being started the swivel gates would be used to isolate the wheel, thus diminishing the starting torque by limiting the churning of the water by the runner. Even so, the torque would usually be too high for motor and power line, but the closed swivel gates would allow the pneumatising of the pump turbine so that the runner could be run up in air. A difficulty is that, when pumping, the gates are in a disturbed flow and have to be locked individually to prevent vibration. Also the passing from a pneumatised machine with closed gates to one delivering water through open gates may be difficult.

Now, looking at the problem, it is obvious that to get the pump head a Francis runner is required, while, if there is to be a chance of suppressing the gate apparatus, this runner must have movable vanes like a Kaplan runner. The answer is then a feathering Francis runner. Intensive research

*Figures given in the general report for section "A" and referring to the year 1953 were:—Pit coal, 51·4 per cent; brown coal, 4·8 per cent; petroleum, 29·3 per cent; natural gas, 12·7 per cent; hydro power, 1·8 per cent; Hydro power was stated to be increasing at an average rate of 8·5 per cent per year, the rate of increase for world energy as a whole being 4·4 per cent.

proved the feasibility and the advantages of this solution, especially as the runner vanes could be designed to close against each other over their full depth and in this closed position to form virtually a smooth cone. The wheel can therefore glide through the water when it is being run up to speed preparatory to pumping and so does not require a large torque. The complication of pneumatising is therefore avoided. At normal speed the runner vanes are gradually opened and the flow builds up. There are no swivel gates in the way of the water leaving the runner, yet by closing the runner vanes backflow from the reservoir can be stopped effectively.

Furthermore the movable runner vanes can be used for the quantitative regulation of the pump in the same way as for the turbine. Thus, when pumping against any given head, the discharge can be varied and the machine operated from part load to overload with good efficiency. This flexibility is of considerable advantage.

To increase the turbine discharge and power at low heads, flaps, pivoted at the end of the diffuser vanes and resembling those used for aircraft, direct more water to the wheel. The flaps, when not operating, form a streamlined extension of the diffuser vanes and are locked in position.

The output parameters finally chosen by the Hydro-Electric Power Commission of Ontario for feathering Francis pump turbines for Niagara are as follows :—

Working as pump :			
Net head, feet ...	59 ...	75 ...	90
Discharge cusecs ...	5,040 ...	4,600 ...	4050
Speed, r.p.m.	92·3 ...	92·3 ...	92·3
Working as turbine :			
Net head, feet ...	60 ...	75 ...	83
Output, b.h.p. ...	24,000 ...	36,000 ...	45,000
Speed r.p.m.	92·3 ...	92·3 ...	92·3

Fig. 4 shows the pump turbine in section. The runner is just over 21ft diameter and has vanes of cast steel ground to template. Since cavitation tests made under the full prototype head of 90ft and with the same submergence for the model as occurs in the field gave very satisfactory results, only the edges of the vanes running over the

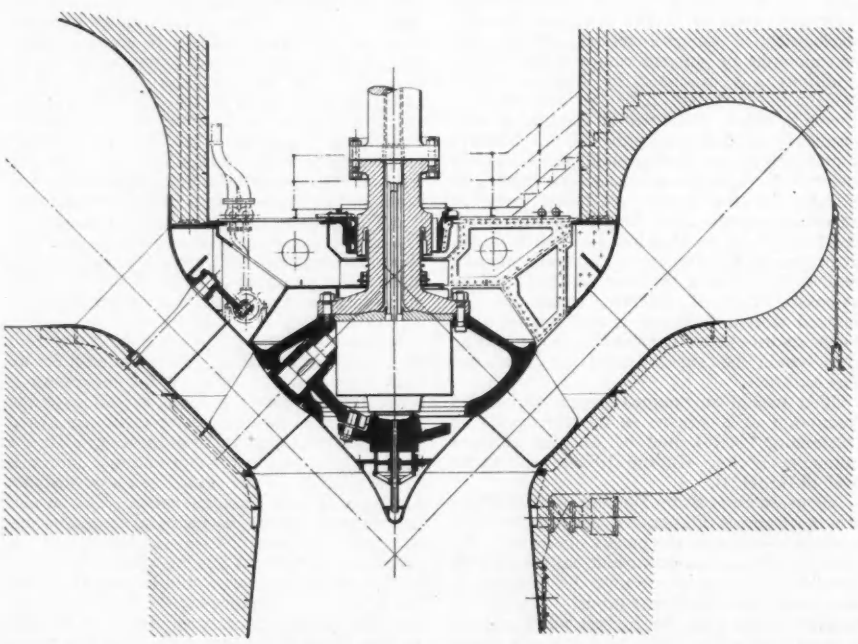


Fig. 4—Section of pump turbine with feathering Francis runner for Niagara pumped-storage scheme

envelope are protected with stainless steel. The runner hub is a massive steel casting. Seals are arranged round the vane collars, the vane trunnions rotate in bushes of special bronze and are fitted with levers rather on the lines of a Kaplan turbine. The oil pressure servomotor operating the vanes is, however, quite different. It has a rotor coaxial with the shaft centre line and operated by radial fins, each working in a separate compartment of the cylinder. A somewhat similar arrangement has been used for butterfly valves. The problem of sealing round the periphery of the fins and against the rotor stem is solved by the application of strips loaded both by springs and hydraulically. The disc at the bottom of the servomotor rotor carries slider blocks engaging with the vane levers. An ingenious mechanism at the bottom converts the motion of the servorotor into the up and down movement necessary for the return motion rod passing down the main shaft of the turbine. As for a Kaplan turbine, there is an oil pressure head at the top of the generator and a distributing valve for the runner servomotor.

The envelope surrounding the runner is lined with stainless steel and is spherical in form, as is also part of the runner hub. Thus the correct small clearance is maintained over the whole length of the vane edges at all openings and gap cavitation is avoided.

For the most efficient recovery of energy when pumping the diffuser (or speed ring as applied to a turbine) is conical, forming a direct extension of the runner passages. This means that the stay vanes are inclined and the form of the speed-ring/spiral casing assembly is somewhat more complicated than usual. Hence the advisability of model tests to check experimentally the calculated stresses resulting from the superimposed loads of concrete and generator and the water pressure.

The whole of the turbine, with the exception of runner, shaft and bearing, is fabricated by electric welding. The bearing is of the submerged type, but instead of having the usual two-part bush, has separate adjustable pads which are water cooled. This design is a little more expensive, but has been fully justified by results.

A conventional oil pressure governor is used to control the opening of the runner vanes. The oil pressure system also supplies the servomotors of the diffuser vane flaps.

In the development of pumped storage, the simplest and cheapest arrangement would be a reversible pump turbine, but as there is wide choice of site the tendency is towards high heads so as to limit the quantity of water and therefore the reservoir sizes for the same output. Consequently, having mastered the problem for the lower head range, research is being conducted, and is showing promising results, at the other end of the scale, with a reversible pump turbine for heads of the order of 800ft.

Nuclear Power

The imminence of nuclear energy as a substantial contributor to the world's energy demands has become apparent since the last World Power Conference was held, and overshadowed the outlook behind many of the deliberations at Vienna. Even so, caution against too much optimism was expressed, the energy problems of the next few years being serious, and nuclear energy being still at too early a stage to assist. Although the possibility of rapid progress in this field was in many delegates' minds, comparatively little new information was given at the Conference. This was to be expected, since the papers were completed only a very short time after the Geneva conference on atomic energy, held last year, at which such full accounts and surveys were given.

The most detailed programme of nuclear power generation given up to the present has come from this country. The programme is well-known, and has been described and commented upon in this journal. The paper by Duckworth, Squire and Newman (194J/13), envisages nuclear plant with a total capacity of 23,000MW (sent out) in service by 1980/81, to supply the base load of the public electricity supply system. These installations would generate about 146,500 million kWh, out of a total generation of 295,000 million kWh. By 1965/66 it is planned to have 3900MW (sent out) of nuclear plant installed, generating 25,500 million kWh annually. These figures are, naturally, tentative, and are based on the installation needed to make up the expected deficit in coal. The programme also assumes gas-cooled graphite-moderated reactors in the early stations.

Some details of Russian aims in nuclear generation were given by Kasakschkovsky, who referred to the 5000kW station in the U.S.S.R. which has now been in operation for two years. It was planned to have 2000MW to 2500MW of plant in service in Russia in the next five years, he said, mainly in power stations 400MW to 600MW in size. Various experimental plants of 50MW capacity—boiling water reactors, homogeneous breeder reactors and fast reactors—were also to be built.

It is well known that the United States has in progress a programme of experimental construction, in which examples of a number of different kinds of reactor are being built, so as to accumulate comparative data on their economics and operation. Several of these projects are now well advanced. Papers giving recent information on a pressurised water reactor (172J/10), a boiling water reactor (171J/9), a fast neutron breeder reactor (270J/18), and reactor plants in New England and New York (173J/11 and 269J/7) were presented to the conference, and a general review of the status of nuclear power technology was also given (169J/7). Nevertheless the American attitude to prediction of the future of nuclear power was generally cautious, in the conference discussions and papers. "Many claim with considerable justification," one author wrote (170J/8), "that discussion of the economics of nuclear power at this stage is meaningless and will continue to be so until we have more operating experience with nuclear power plants." Another United States author concluded (169J/7), "Economic nuclear power is not yet here, except perhaps under very special circumstances. However, it does seem quite possible and feasible even in the United States, where we have large resources of conventional fuels—fuel which perhaps can be conserved for more important uses."

Papers on nuclear power schemes under construction, or projected, were also submitted from Sweden, Holland, France and the Federal Republic of Germany, and an Austrian author contributed a paper on reactor control. The development of small plants of 40MW capacity or less was commented upon by one United States speaker. Such plants had special applications, he noted, and were important in some parts of the world. A 22MW boiling water reactor, and a 10MW homogeneous reactor were thus being developed in the United States.

British speakers at the conference were able to report the successful completion of the first trials of the Calder Hall reactor. Mr. Gott said that there had been good agreement between the behaviour of the plant in operation and the design calculations. Further details of the Calder Hall power station were given in a paper by a group of authors who have been concerned with its design and construction (239J/16).

Other Sources of Energy and their Utilisation

We summarise section " K " of the conference by abstracting from the general report, which was by Professor Thirring of Vienna University.

Of the eleven papers received, which fall within the scope of section " K," three deal with the use of geothermal heat, one with utilisation of carbon dioxide issuing from the earth under pressure, two with methane from mines, one with the energy of the sun, while the remaining four concern special methods for the utilisation of sources of energy. Papers have not been received about wind power plants, nor about the utilisation of natural differences of temperature. The papers concerning tidal power stations are dealt with in section " H " (111H/22).

Carbon Dioxide Power Stations.—Paper K/3, by A. Levai and D. Halasz, of Budapest, deals with the general problem of economical utilisation of high-pressure carbon dioxide wells. The numerous natural gas wells issuing carbon dioxide, either pure or mixed with steam or methane, generally produce more gas than can be bottled in high-pressure cylinders and used for chemical purposes. The high pressure, which often reaches 80 to 100 atmospheres, and the magnitude of the reserves which are of the order of 10^9 cubic metres, seem to make the utilisation of the gas for the direct production of power in gas turbines with little or no consumption of heat an economically favourable proposition. With an initial pressure of 80 atmospheres and an inlet temperature of 40 deg. Cent. power could be produced by expansion to atmospheric pressure without additional heat consumption, using about 25 kg of carbon dioxide per kilowatt-hour. However, the expansion cannot be made adiabatically because the temperature would drop below the freezing point of carbon dioxide and the formation of carbon dioxide crystals would endanger the turbine blades. Therefore at least one reheating stage must be provided which at low temperatures could operate without fuel, using atmospheric air as the source of heat, provided the heat exchangers and air blowers are sufficiently large. If the carbon dioxide from the well is not pure, but mixed with steam, then the temperature must not drop below 0 deg. Cent., and in this case a certain consumption of heat is required for both preheating and reheating.

A gas well with an assumed reserve of 3×10^9 cubic metres of carbon dioxide at a pressure of roughly 100 atmospheres could keep a 200MW plant going for twenty-five years at an annual load factor of 5000 hours.

Utilisation of Methane from Mines.—Paper K/5 deals with the application of a new process, described by R. Forstmann and P. Schulz, for the extraction of methane from mines in the Saar region and gives a review of the possibilities of using the gas thus obtained. The methane originated during the formation of the hard coal from the forest bogs of the carboniferous period, when it was absorbed in the submicroscopic pores of the coal under pressure. When the coal is mined the gas is liberated as a result of the changed pressure conditions and brought into the air in the pit. It has always been necessary to draw off the methane by proper ventilation so as to avoid fire-damp, but since the end of the second world war the " bore-hole method " proposed by Schulz and Forstmann has been used in many pits to extract the gas from the coal even before the latter is mined. The method consists of boring, from neighbouring galleries, holes of up to 100m length into those parts of the seams in which a pressure drop may be expected due to forthcoming mining operations. These holes are tightly connected to pipes making up a collecting system leading to the surface. The small amount of vacuum necessary for extraction is produced by a blower.

Apart from decreasing the danger of fire-damp the bore-hole system has the advantage of supplying considerable amounts of high-quality gaseous fuel in addition to the coal mined. In the average mine in the Saar area the yield of methane is, in the mean, about 30 standard cubic metres for each ton of coal mined. Since this method was first introduced in 1950 the quantity produced has risen from 60,000 to 620,000 standard cubic metres per day in 1955 ; after the completion of the last of the present installations an annual production of 234 million standard cubic metres is expected in 1956, referred to standard gas with an upper calorific value of 4300 kcal per standard cubic metre. Apart from the increase of safety in the mines, there is an additional yield of energy amounting to roughly 10^{12} kcal per year.

Earlier, when it was only available in smaller quantities and when petrol was scarce, methane was used mainly as fuel gas in pressure cylinders. Nowadays part of it is burned directly in power stations and cokeries owned by the coal mines, whilst part is fed into the long-distance gas grid, after treatment in a cracking plant.

Solar Power Stations.—In contrast to the World Symposium on Applied Solar Energy, held in Phœnix, Arizona, in 1955, the Fifth World Power Conference regrettably has received only one paper, K/6, on the utilisation of solar energy. This paper deals with a special type of radiation collector for solar power stations. To produce steam for such a station shallow boilers can be used, whose blackened exterior forms the collector, which is mounted nearly at right angles to the incident sun rays. The moderate temperatures generated can be used to obtain sufficient pressure in low boiling liquids, such as sulphur dioxide, to run a piston engine or a turbine. However, since condenser temperatures cannot be less than those of the cooling water, the difference between boiler and condenser temperature is very small, and therefore the thermal efficiency low. To obtain higher temperatures one has to employ, as was repeatedly attempted as early as the nineteenth century, methods of focusing, for instance by mounting a cylindrical boiler in the focal line of a cylindrical parabolic mirror. This results in higher temperatures and a higher thermal efficiency, but on account of the necessary heliostatic mounting of the mirror the initial costs will be considerably higher than for installations with flat collectors.

The improvement suggested by Tabor in his paper consists of using for steam generation a flat collector, whose surface is covered by a thin layer of certain metal alloys which renders it a " selectively black " body. If, in addition, a properly transparent cover plate is mounted, airtight, at a certain distance above the irradiated area and the internal pressure is reduced by a vacuum pump a " solar trap " is formed, whose effect is much greater than that of the normal glasshouse. In this way higher temperatures can be obtained, so that even water can reach the steam pressure required for an acceptable thermal efficiency. One may therefore anticipate the possibility of combining the lower costs of the flat collector with the higher efficiency of the more expensive installations equipped with focusing concave mirrors.

For improving efficiency further, paper K/6 advocates the construction of a machine with dual heating, in which the saturated steam is produced in a solar boiler with a selectively black flat collector, whilst conventional fuels such as pulverised coal or fuel oil supply the heat for the superheater. With an overall efficiency of 11 per cent and a coal price of 20 dollars per ton the saving in fuel, under conditions as obtain in Jerusalem, would be worth while provided it is possible to produce solar boilers at a price below 24 dollars per square metre of collector surface.

Purification of Waste Water and Gases

" The purification of waste water and exhaust gas in the production and use of energy " was the subject of division IV of the conference. Achievement of effective purification of these waste products is assuming greater importance as energy consumption increases throughout the world. Nevertheless, the general reporter (Dr. R. Liepolt) for section " L," which dealt with water purification, noted with regret that only three papers had been presented in that section. However, an attempt at a comprehensive survey of waste water treatment, with references to relevant technical literature, was made in the general report itself. The three papers dealt with German purification techniques at power stations (78L/1), a survey of treatment problems for effluents from gas and coke plants in France (222L2) and a general survey of the British approach to waste waters in the fuel-producing and fuel-utilising industries (240L/3).

There were five papers in section " M," on the treatment of waste gases, Four of them dealt with various problems of power station ash and dust, including some advances in precipitator design (242M/5 and 101M/4). The fifth paper was a survey of air pollution in Great Britain, submitted by Dr. A. Parker (9M/1). This paper was of considerable general interest and gave details of the amounts of air pollution of various kinds experienced in this country, and of the work done in measurement and investigation. The cost of damage by air pollution in Great Britain was estimated, in the paper, to be equivalent to at least £250 million a year ; that estimate did not include much of the damage to health. Pollutants from the burning of coal and petroleum oils during 1954 were estimated at 2,000,000 tons of smoke, nearly 1,000,000 tons of grit and dust, more than 5,000,000 tons of sulphur dioxide, and between 20,000,000 and 30,000,000 tons of carbon monoxide. Solid matter was deposited at a rate equivalent to between 500 tons and 2000 tons per square mile in some thickly-populated areas. Dr. Parker considered that, on the basis of existing knowledge, a considerable reduction in the pollution of air by smoke, grit and dust, and some reduction in pollution by carbon monoxide, could be obtained. Satisfactory methods, at reasonable cost, of appreciably reducing pollution by oxides of sulphur had not yet, however, been developed.

International Co-operation

Technical and economic problems of international co-operation in the production and use of energy were discussed in division V (sections " N " and " O," respectively) : this division was the only one in which British papers were not presented. The principal problems were those concerned with international electricity transmission, and the development of hydro-electric schemes in frontier regions, such as the proposed Interalpen scheme. However, these were by no means the only problems involved. Exchange of experience and knowledge was also discussed in the section " N " general report, written by Dr. Mengele, who commented on such subjects as the training of engineers and regulations and standards as they affected technical aspects of international co-operation.

The host country of the conference, Austria, is particularly affected by these international problems ; European transmission networks and their relevance to Austrian power schemes were discussed in several papers (5N/2 and 8N/3). The work of the International Gas Union was also described in one paper (271N/9), and another international organisation, U.C.P.T.E. (d'Union pour la Co-ordination de la Production et du Transport de l'Electricité) subscribed a paper to section " N." (234N/8) Economic topics included a review by the O.E.E.C. (236O/7) of the effect on the economies of its member countries during the period 1955–1965 of their combined fuel and power policies during that period. The long-term conclusions drawn from that study were that : (*a*) long-term financial arrangements were needed; (*b*) balance between the development of national fuel resources and outside sources was also needed ; (*c*) a fuel and power price policy to encourage private investors was of importance, and (*d*) more rational use of fuels would ease the heavy burdens of capital investment.

High Speed Photography Congress.—The Third International Congress on High Speed Photography will be held from September 10th to 15th, at the Government Offices, Horseguards Avenue, London, S.W.1. At the congress some fifty papers will be presented in two main groups, techniques and applications. Under techniques the following subjects will be discussed : inertia-less shutters, mechanical optical drum cameras ; image sampling ; schlieren, interferometric and stereoscopic techniques ; X-rays ; medium repetition rate cameras ; photographic materials ; instrumental aids. The applications group will include : biology and medicine ; machine analysis ; ballistics and explosives ; aerodynamics ; hydrodynamics ; film evaluation. An exhibition held in conjunction with the Congress will demonstrate the latest cameras, flash equipments, film analysers, &c., in use by commercial organisations, Universities and Government Departments.

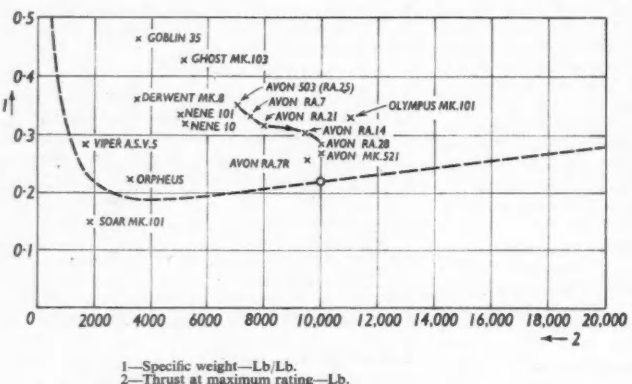
Gas Turbine Developments in Aeronautics

By A. W. MORLEY*

The proceedings of the Fifth World Power Conference, Section, G_3 included a review of design trends evident in British aircraft turbines. We abstract below a part of the paper, which concluded with notes and tabulated data on thirty-one engines.

Turbo-Jet Units

THE turbo-jet engine has shown an increased adaptability to a wider range of requirements than was generally expected a few years ago. As a result its field of application has grown and there are a number of definite directions along which development proceeds. There is the steady trend towards increased size, as is necessary to meet military demands and the needs of larger transport aircraft, where refinement in gas turbine design and improved materials have enabled the designers to offset the weight increases due to the square/cube rule (see Fig. 1). Here the improved robustness which comes with size has led to a more rugged and therefore more acceptable power unit and one in keeping with the demands for maximum simplicity. Following another school of thought, by taking advantage of the square/cube law, the medium size unit has opened up considerably the possibilities for supersonic flight. The substantial increase in thrust with forward speed, following upon the increased air-swallowing capacity of the engine when correctly matched with a suitable air intake and exhaust system, along with the use of improved materials for compressor and turbine, makes the jet engine eminently suitable for cruising speeds of $M=2$ and over, provided weight and drag minima which are believed possible with the optimum size of unit are attained. Again, it is argued that by obtaining the minimum specific weight of which the turbo-jet is capable it becomes possible to achieve vertical flight direct from take-off and during approach. These latter developments have produced much speculation and in some cases quite realistic advances in thought, opening up new vistas in aircraft employment, both civil and military.



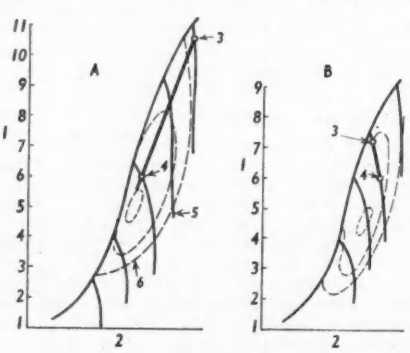
1—Specific weight—Lb/Lb.
2—Thrust at maximum rating—Lb.
—›Typical development trend (Avon).
— — —Typical present day design target curve drawn arbitrarily through "0."

Fig. 1—Specific weights of turbo-jet engines (sea level static) from published data

Much thought and experiment is currently given to problems of the supersonic jet engine which, we believe, will eventually find application in aircraft cruising in the Mach number range 2 to 2·5. Under these flight conditions the optimum pressure ratio is well within the bounds of a single-spool axial compressor provided present turbine temperatures can be improved. However, the high total temperature of the air entering the compressor makes air cooling more difficult. It also reduces the specific (or non-dimensional) speed of the compressor, and the problem of the best means of controlling the engine has important repercussions on the basic design (see Figs. 2 and 3). For example, to suit the compressor it would be advantageous to maintain constant specific speed (Fig. 2, *B*) rather than constant revolutions per minute (Fig. 2, *A*) as the prime operational limitation. However, in order to operate a jet engine thus regulated to a fixed turbine inlet temperature limitation, it becomes necessary to vary the geometry of the final propelling nozzle, and also the geometry of the air intake (Fig. 3). The intake acts as the first part of the compressor and must match it in air flow rate without a severe loss in the pressure gained from the ram by diffusion. It must also prepare the air flow for proper entry into the bladed section. In supersonic flight part of the intake compression may be performed externally by a shock wave system. Special means are required to permit operation at full mass flow at subsonic speeds. For the higher forward speeds the propelling nozzle must be convergent-divergent in order to obtain full thrust; at low speeds difficulties which arise with mismatching require that some system of throat control is provided.

The possibilities of a considerable advance in high-speed, high-altitude performance are so great that there is a strong development trend along these lines. Due to the objections arising from the reheat system—its size and drag, its poor thermal efficiency, the necessary complications of a variable geometry exit and convergent-divergent nozzle, the diminishing returns as turbine temperatures increase—reheat offers a decreasing advantage. Hence there is considerable scepticism about the forward development of reheat to meet the advent of these engines of advanced supersonic type.

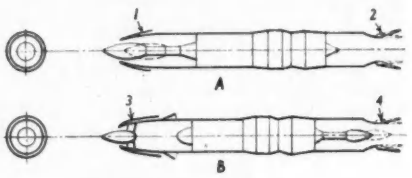
Mention should be made of the by-pass type of jet engine in which some of the intake air, partially compressed, is bled direct to the propulsive stream, without taking part in the process of combustion. The object of this feature is to reduce the mean velocity of the propulsive jet and so improve the overall efficiency of the engine. With this form of engine the specific fuel consumption at transonic forward speeds will be significantly better than those attainable with the simple jet. This advantage is expected by some designers to remain positive after making proper allowance for the increased frontal area and weight of the by-pass unit. However, it would appear that there is only a narrow field of cruising speed where the by-pass can be significantly superior.



A—Constant r.p.m. engine.
B—Constant $N/\sqrt{T_1}$ engine.
1—Pressure ratio P_2/P_1.
2—Compressor mass flow $Q\sqrt{T_1}/P_1$.
3—Sea level.
4—Altitude top speed.
5—Constant $N/\sqrt{T_1}$.
6—Constant efficiency.

Fig. 2—Turbo-jet for supersonic flight for M=2·5

The by-pass engine is more exacting than the simple jet as regards the aerodynamic behaviour of its compressor, and it is not so forward in development as the turbo-prop. Since it needs a two-shaft construction and has coaxial ducts along its length, it has special problems in structural and mechanical design. Though its success in production, in a large size, is still to be proved, there is considerable belief in its eventual value, principally on account of its improved fuel economy. Also it has certain advantages of importance to civil operators, such as reduced jet noise and the added safety of the cool outer duct.



A—Constant r.p.m. engine.
B—Constant $N/\sqrt{T_1}$ engine.
1—Variable intake throat.
2—Variable final nozzle exit.
3—Fixed intake with blow-off.
4—Variable final nozzle throat and exit.

Fig. 3—Turbo-jet for supersonic flight for M=2·5. Altitude, thrust and fuel consumption same for A and B. B requires 10 per cent smaller compressor and three fewer compressor stages

Turbo-Prop Engines

The tardy development of the axial-flow turbo-prop is due to a variety of detail problems which have arisen in the course of experience with prototypes, and which have taken up a great deal of time with the resources available. The time factor introduces difficult problems: to be commercially successful, engine, propeller and airframe must be ready for the market together; a difficult achievement which can only be partly controlled even in the largest of industrial groups.

The normal British design practice in axial turbo-props is to carry the propeller shaft and reduction gear as part of the engine structure at the front of the engine. The compressor design is not prescribed by frontal area, as in the jet engine, and is chosen so that the main rotor has optimum speed in relation to overall engine weight and compressor performance. All the turbo-props indicated in Fig. 4 with the exception of the "Dart" are axial-flow compressor engines.

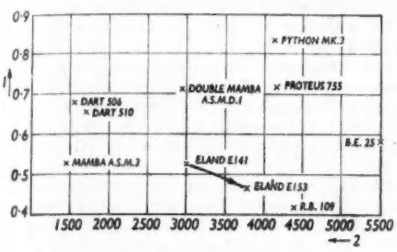
With a turbo-prop engine improved economy in fuel can be achieved by increasing the pressure ratio and turbine inlet temperature. The latter variable has also a predominant influence on power output. Hence the tendency is towards a high gas temperature because it scores on both counts, power and economy. Research units have given ample demonstration of the benefits of increased temperature and of the feasibility of cooling schemes; but the rate of progress towards standardisation with increased gas temperatures is very slow.

The other major trend in development, again to assist fuel economy, is towards increased pressure ratio. Due to the fact that the stages of an axial compressor, if matched at full load, will be unmatched at part load, it becomes increasingly difficult to step up pressure ratio by adding more stages to the same unit while at the same time maintaining sufficient flexibility and economy at part load. One line of advance is to develop a two-shaft engine with the compressor divided into l.p. and h.p. sections as in the two-shaft jet. In this case the propeller power must be taken off the l.p. or outer pair. The design of such an engine is not so circumscribed by the common

*D. Napier and Son, Ltd., London

single-shaft aerodynamic limitations but has problems of its own which become evident when one sets out to decide the best division of pressure ratio between the two shafts. The number of turbine stages required for the total compressor work is usually either two or three, and the decision of where to divide them and so proportion the pressure ratio between h.p. and l.p. shafts is far reaching. One aspect of this is seen in the matching problem, which is illustrated in Figs. 5 and 6 for a hypothetical two-shaft engine.

If the greater share of the pressure ratio is taken on the l.p. shaft, as in Fig. 6, so that an efficient single-stage h.p. turbine can be employed, there should be a good operating line on the l.p. compressor map. Thus for maximum flexibility and best overall performance the operating area for steady running on the l.p. compressor map should be restricted to a narrow band, irrespective of the particular l.p. and h.p. shaft speeds, intake temperature, intake pressure, and turbine temperature. To allow for swing under transient conditions this operating area



1—Specific weight—LB/E. S.H.P.
2—Power at maximum rating (E.S.H.P.) sea level.
—→Typical development trend.

Fig. 4—Specific weights of propeller turbine engines from published data

could with advantage be reduced to a single operating line. It can be shown with certain simplifying assumptions that this desirable condition is obtained when the h.p. pressure ratio (r_H) is given by

$$r_H = \left\{\frac{2\eta\gamma}{\gamma(2\eta-1)+1}\right\}^{\frac{\gamma}{\gamma-1}},$$

where η is the polytropic efficiency of the compressor and γ the specific heat ratio. Accordingly the h.p. pressure ratio required to give a unique operating line is almost independent of the overall pressure ratio ($r_L \cdot r_H$) of the engine. In practice r_H does not remain a constant, for it changes with engine operating conditions ; the theoretical value suggests a mean value for the operating band. It suggests a low h.p. pressure ratio, 1·725 : 1 if the compressor polytropic efficiency is 90 per cent, which fits in with the use of a single-stage turbine on the h.p. shaft.

With the " unique " operating line there is maximum l.p. flexibility. However, this condition implies nearly a constant non-dimensional mass flow on the free h.p. compressor, and since the h.p. line is then nearly vertical, the h.p. compressor will move towards surge as the h.p. speed increases. It follows that the turbine inlet temperature at full revolutions per minute will increase at low air intake temperatures and decrease at high intake temperatures. This will impose a limit on the power at the warm end of the air inlet temperature range, i.e. at low altitudes, where the output at full revolutions per minute will be well below the potential power of the turbine.

On the other hand, if the h.p. turbine is designed with more than one stage, thus requiring a greater share of the compressor work to be carried on the free h.p. shaft, as in engine Fig. 5, other troubles will appear. The engine will not be so temperature sensitive, but the operating point on the l.p. compressor will cover an area on the compressor map and will tend to move towards the surge line as power is reduced, so limiting the natural flexibility of the engine. These inherent design problems will no doubt be overcome at the cost of some refinements in control and some loss of potential output and efficiency.

Two out of the three latest British turbo-prop developments have the two-shaft construction. It is generally believed that two shafts would be quite unnecessary if a satisfactory means were found to make freely useable all the pressure ratio commonly obtained to-day on a single shaft.*

Another design controversy concerns the use of the free power turbine. If the power turbine is not mechanically linked to some or all of the compressor stages, the propeller running speed is not rigidly dictated by engine speed, and some valuable flexibility is thus added to the engine. This can result in improved starting, and a useful lowering of propeller noise. However, the turbine rotor has very little inertia, which will be a serious drawback in certain failure cases where the designer has to rely on the rapid operation of the governor for catching the turbine should it become suddenly detached from the propeller load. Again, the torque of a free turbine does not reach a steady value until the compressor unit comes up to equilibrium speed. With a large high-speed compressor this means the response of the engine to throttle movement is delayed. The output of the fixed-shaft turbine is not subjected to variations in the speed of the compressor, though it is usually necessary to phase propeller pitch change and revolutions per minute change during acceleration and deceleration in order to get a smooth power response. On the other hand, the fixed-shaft turbine is at a disadvantage with regard to its high windmilling drag, which can be a major problem in a case of sudden engine failure. To combat this the propeller pitch is not allowed to come below a certain limit in flight, and the pitch change mechanism is arranged so that the blades can be rapidly feathered, if necessary.

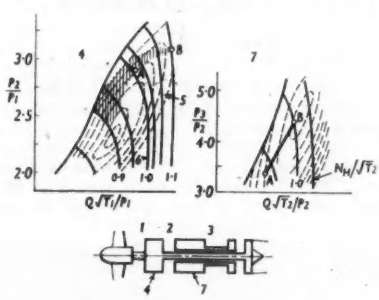
The Helicopter Gas Turbine

Developments are in hand in Britain for three different types of helicopter propulsion by gas turbine engine. These are :—

(*a*) Mechanical drive to the rotor head by a power turbine, which in principle is similar to the turbo-prop engine with a free turbine.

(*b*) A gas drive using the pressure gas discharge from a form of by-pass jet engine to drive the rotor by tip jet reaction.

(*c*) By a power unit which combines a normal propeller drive for forward thrust with a drive



A—Sea level take-off.
B—Altitude cruise.
4—L.P. compressor.
5—Constant efficiency lines.
6—Constant $N_L/\sqrt{T_1}$ lines.
7—H.P. compressor.

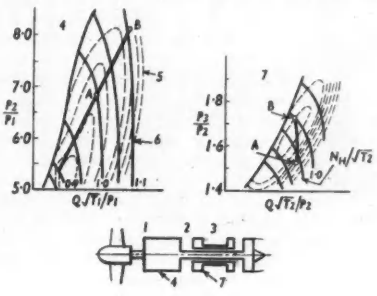
Fig. 5—Two-shaft propeller turbine matching points. Compressor with 6 l.p. stages and 12 h.p. stages. L.p. point moves over area shaded

to a large air compressor which comes into use when the power is taken away from the forward propeller, and which then supplies compressor air to the rotor tips, where fuel is burned to give a rotor drive by jet reaction.†

These three applications are all suitable for twin or multi-engined aircraft, so that the helicopter designer can cover the engine failure cases. The following remarks will assume a twin-engined arrangement is employed.

The gas turbine is particularly attractive for helicopter propulsion because of its low weight per horsepower, freedom from vibration, simplicity, compactness, and its ability to use liquid fuels of less fire risk than petrol. It also provides a suitable form of rotor drive, either by free turbine or by tip jets, where the rotor speed can be chosen with greater freedom because it is not linked rigidly to engine revolutions per minute. The high first cost and relatively heavy fuel consumption at part load are to a large extent overcome by these advantages, and it is apparent that the gas turbine is making considerable progress in its application to this form of transport.

A leading design problem of the mechanical drive scheme (a), which is probably the most forward of the three mentioned above, is the need for an emergency power greater than normal " fixed wing " maximum to meet certain single



A—Sea level take off.
B—Altitude cruise.
4—L.P. compressor.
5—Constant efficiency lines.
6—Constant $N_L/\sqrt{T_1}$ lines.
7—H.P. compressor.

Fig. 6—Two-shaft propeller turbine matching points. Compressor with 13 l.p. stages and 4 h.p. stages. L.p. point moves along " unique " line AB

engine failure cases. The tip jet schemes (*b*) and (*c*) can meet this by burning more fuel at the rotor tips, which is akin to the use of reheat for boosting the simple jet engine, but the same method cannot be applied to a shaft drive. There are various possible ways of augmenting the power for short periods, and, provided the period is short enough, ample overload can be carried. However, the engine control system must be able to handle the quick manœuvre.

In the scheme (*b*) a by-pass jet cycle is used and the two streams, turbine exhaust and by-pass air, are mixed and delivered to the rotor head to provide tangential propulsive jets at the blade tips. The gas turbine cycle is thus employed so that all the output is delivered as pressure gas and at a temperature which is within rotor limitations and yet high enough to give a satisfactory heat drop at the tip nozzles. In this system the final tip jet nozzle must be controlled to suit running conditions, but in practice it can remain fixed over a wide running range. A major advantage is the absence of gear losses in the pressure gas drive so that no oil cooling is required. Losses in pressure and temperature in the ducting and rotor blade must be reduced to a minimum. Internal ducting and tip nozzle characteristics must be closely tied in with the engine design.

In the third scheme under development the engine is based on a fixed-shaft propeller turbine which operates as a normal propeller turbine when in forward flight, the lift being taken from fixed wings. The auxiliary compressor for supplying the rotor power is driven direct from the main power turbine through a hydraulic clutch, and it compresses free atmospheric air. In forward flight the clutch is empty, no power passes to the auxiliary compressor and so the rotor windmills. In hovering flight the clutch is filled and the propeller put into fine pitch. Then about three-quarters of the full engine shaft power is available to drive the auxiliary compressor, which delivers the corresponding quantity of air direct to the rotor head. The delivery air pressure is such that tip jet burning can be used with reasonable economy under the hovering condition.

The aircraft is designed to take off and climb vertically on the rotor with sufficient propeller power for yaw control, and permits the pilot to reach a safe forward speed by tilting the aircraft forward after the manner of a normal helicopter, when at a suitable height above the ground. The engine power is then switched from the com-

* " Single-Spool Turbo Prop," interview given by A. J. Penn, *Flight*, June 17, 1955, page 481.

† Examples are : (*a*) Napier " Gazelle " in Bristol 192 ; (*b*) Napier " Oryx " in Hunting Percival P.74 ; (*c*) Napier " Eland " N.El. 3 in Fairey " Rotodyne."—Ed. The E.

pressor to the propellers, so that the rotor is unloaded as lift develops on the fixed wings.

This is another gas turbine development in aeronautics which emphasises the necessity for a comprehensive control to take charge of simultaneous changes in engine speed, propeller pitch and compressor inlet conditions.

Development Leading Towards Improved Fuel Economy

Combustion.—With present techniques a typical maximum heat release rate is 2×10^6 C. H. U. per hour per cubic foot per atmosphere, and the combustion efficiency is usually in the range 97–99 per cent. This means that in normal operation nearly all the available heat is released from the fuel before it leaves the combustion chamber.

The aerodynamic aspects of combustion chamber design are more or less amenable to experiment. Generally speaking, the overall pressure loss must be less than 15 per cent, and the flow velocities low enough to ensure this, at the same time giving good mixing. It is known that efficiency can only be high if the temperature in the reaction zone is sufficiently above the ignition temperature. This condition is not obtained with light loads at high altitudes because the ignition temperature is high on account of the low pressure, neither is it satisfied where the ignition temperature is high because the residence time of the fuel and air mixture in the chamber is too brief. Consequently combustion efficiencies will suffer under such conditions.

Higher Turbine Inlet Temperatures.—An increase in maximum turbine inlet temperature increases the output and also improves the efficiency of the thermodynamic cycle. In a turbo-prop a gain in cycle work leads directly to a greater power output and a better specific consumption. This is not necessarily so with a turbo-jet, where the increased cycle work increases the velocity of the propulsive jet ; this increases the thrust but also adds to the cycle work rejected as jet k. e., which usually worsens the specific fuel consumption.

With the turbo-jet at high forward speeds the desirable turbine inlet temperatures for best economy of fuel are increased. For example, it is feasible to nominate a temperature of 1400 deg. K at turbine inlet for a Mach No. 2 engine, whereas 1100 deg. K. is normal for a subsonic application.

The by-pass principle, with its lower level of rejected k. e. has a better propulsive efficiency than a simple jet, so that the s. f. c. as well as the thrust is improved by increasing the turbine inlet temperature, provided the other major design variables are arranged to suit.

With the turbo-prop and helicopter gas turbine there is every incentive to improve the turbine inlet temperature. A promising line of advance in these engines, within existing knowledge and using present-day materials, is to employ air cooling. In one system pressure air is tapped from near the delivery of the main compressor, and fed to the critical parts of the engine in such a way that there results the greatest possible improvement in performance for the work expended in compressing the air. There are a number of difficulties to be overcome. The turbine first-stage rotor blade is a typical hot part ; here the heat transfer is greatest near the leading edge, yet the trailing edge is more difficult to cool in relation to the local stress because it is not so easy to bring the cooling medium into effective contact with the blade surface where the section is very thin. The aerofoil best suited to give minimum heat transfer from the hot gas and most effective internal cooling will not generally be the best from the point of view of blade aerodynamic efficiency. The cooled blade is a good deal more difficult to make and fix into the disc than a plain solid blade. It must possess sufficient strength to ensure safe operation under rapid load changes and continuous operation over long periods.

It is of interest to note that three major firms in the United Kingdom are at present developing turbo-props with air-cooled blades.

Institution of Civil Engineers' Conversazione

The Institution of Civil Engineers held its annual Conversazione on June 19th. This event included the usual display of engineering models and scientific instruments, some of which are described hereunder.

THE 108th annual conversazione of the Institution of Civil Engineers took place on Tuesday, June 19th, with its customary pomp, and members and their guests were received by the president, Mr. W. K. Wallace. The principal interest in the conversazione for readers of this journal lies in the display of engineering models and apparatus which accompanies it. This display never fails to include technical innovations of one kind or another, and its scope is very wide. There are, of course, models of civil engineering works in course of construction, also exhibits of scientific instruments and apparatus. The practical interests of the engineer are not, however, neglected. The display this year, for instance, included an exhibit of devices for the protection of valuables, used by the Ministry of Works. They included supersonic, v.h.f., air-pressure and "invisible ray" devices to prevent unauthorised entry to valuables, and also burglar-proof locks. The use of these security devices, it was pointed out, not only leads to economy in manpower, but also secures substantial reduction in insurance premiums.

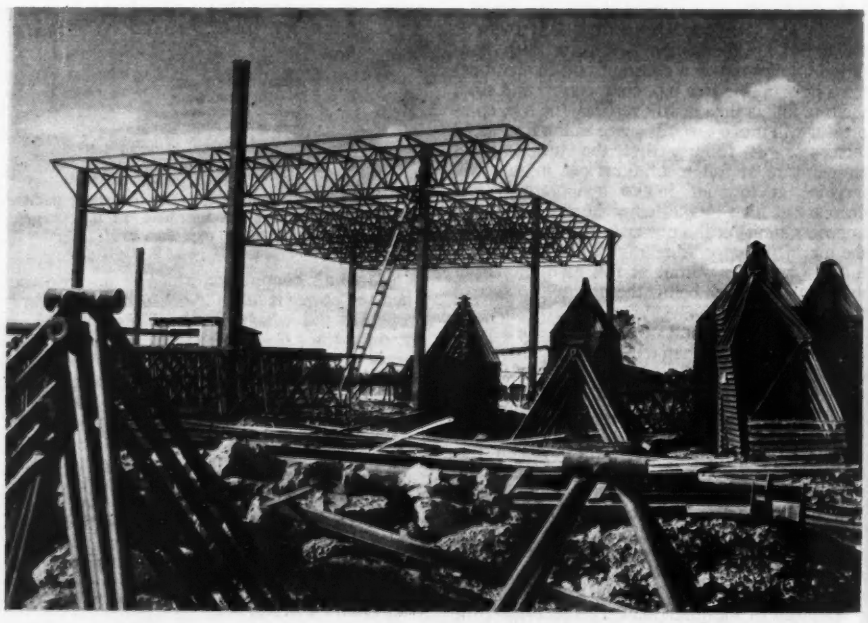
A Prefabricated Roof Structure.—A structural system having something of the originality of conception associated with the Bailey bridge, was exemplified by a model of a load-bearing space frame, which can be erected from simple prefabricated elements. Actual structural works using this method are shown in two of the accompanying illustrations. As may be observed the basic element is a welded tubular steel frame shaped like a pyramid. These pyramidal elements are placed in the frame with their bases at the top, and tie rods are fastened between their apices to complete the structure. The tie rods can be adjusted with turnbuckles, the final result thus being a space-frame with a structural depth equal to that of the basic pyramid. The method allows for the following structural requirements : (a) components play their full part efficiently ; (b) ultimate load capacity is related to the total strength of the system and not to the strength of individual members ; (c) point loads are most effectively distributed ; (d) tie-rod adjustment eliminates fabrication tolerances and dead-load deflection ; (e) deck-patterns may employ less than 100 per cent of units thus giving flexibility in planning and economy in dealing with light loads ; (f) decks may be subsequently strengthened, column positions may be changed, or the structure demounted.

A further advantage is that the pyramidal elements can be "nested" for transport or shipment, as shown in the first illustration. The basic pyramid is 4ft by 4ft in size, and can be built up to form a bridge structure of 40ft span, complying with Ministry of Transport loading. Alternatively, two-way roof spans springing from continuous edge beams of 108ft by 108ft can be formed ; using isolated column heads, a roof can be built on a 60ft by 60ft grid.

We illustrate erection of a roof structure in progress for a factory at Rangoon. The consulting engineers who have developed this system, and who exhibited the model at the conversazione, are Messrs. Bolton, Hennessey and Partners ; the contractor for the structure at Rangoon is Holland and Hannen and Cubitts, Ltd.

The Measurement of Pore-Water Pressure.—The shear strength properties of a soil may be derived from the results of a series of tri-axial compression tests. In these tests a cylinder of soil is enclosed in a rubber membrane and is subjected to a constant external water pressure and a vertical stress which is increased until failure occurs. During the test, internal water pressures are developed within the pores of the soil. As the shear strength of the soil depends upon the difference between the external stresses and the internal pore pressure, it is necessary to measure these pressures.

To ensure that no dissipation of pore pressure occurs it is necessary to keep the volume of the sample constant. Most normal methods of pressure measurement involve some volume change to actuate the measuring device and are therefore unsuitable. An apparatus shown at the conversazione enabled the pore pressures to be measured whilst maintaining the volume of the sample constant. The pore-water pressures set up during the test was communicated to one side of a mercury "U" tube. On the other side of the "U" tube there was a water displacement system consisting of an actuator operating hydraulic bellows and a pressure gauge. The system was filled with distilled de-aerated water.



Erection of prefabricated space frame. The frame comprises pyramidal elements with their bases uppermost, the apices being connected by tie rods. Nests of the pyramidal elements may be noted

At the two levels of the mercury in the "U" tube were two photo-electric cells coupled to a sensitive amplifier which controlled the actuator operating the bellows. Any movement of the pore water tended to alter the mercury level. This in turn, via the photo-electric cells, unbalanced the amplifier and the actuator operating the bellows moved until balance was restored. The opposed forces on the mercury column were then equal, and the pressure shown on the gauge was equal to the pore-water pressure. This apparatus was shown by Mr. M. G. R. Smith, Chief Civil Engineer, Western Region, British Railways.

Distribution of Load Among a Group of Piles in Clay Soil.—When piles are driven in a group each one affects the behaviour of its neighbours. Because of this the average load per pile of the group, in clay, when failure is reached, is lower than could be carried by a single isolated pile, while the settlement of the group is many times that of a single pile. Both the gross action of groups, and the individual behaviour of the piles in groups are problems being considered by the pile driving committee of the Institution of Civil Engineers, and are subjects of current research at the Building Research Station.

Because of the expense of testing full scale structures in the field, models are of great value to enable the factors governing group behaviour to be examined. In the models displayed at the conversazione, the piles could be driven singly, in any order or pattern to follow field practice. The way in which a central load placed on the pile cap was shared among the piles in the group was found by fitting each pile with a small load measuring gauge. The load gauges displayed were virtually tiny proving rings, using electrical resistance strain gauges as the sensitive elements. This apparatus was shown by the director of building research, D.S.I.R., Dr. F. M. Lea.

Prestressing Jack for Reinforced Concrete.—A jack for prestressed concrete exhibited was a first working prototype. It weighed less than 10 lb and occupied a cylindrical space 4¾in long and 4in in diameter. It was capable of exerting a pull of 25 tons on a reinforcing bar and had a travel of nearly 1in. Its purpose was to enable bars to be stressed in concrete members cast as part of a framework. The bars to be stressed needed only have their ends threaded and exposed in a box measuring 8½in long, 4in wide and 3in deep. The method of stressing was simple, requiring only the hand manipulation of a pair of nuts on the ends of the reinforcing bar. Other jacks of a greater capacity are under construction, but it is anticipated that a very limited range of sizes will suffice for all normal field conditions. The jack was designed by Mr. Visvesvaraya working under the direction of Professor A. L. L. Baker, at Imperial College.

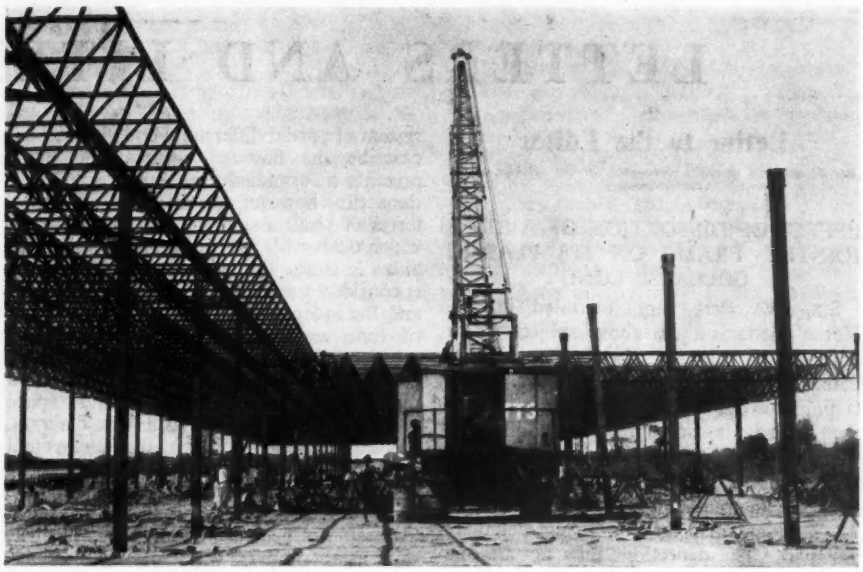
Continuously Recording Physical Phenomena.—An apparatus exhibited by Dr. A. R. Collins, technical director of the Cement and Concrete Association, consisted of a photographic recorder to provide a continuous graph of the movement of a light spot reflected from a mirror extensometer. The particular novelty of the apparatus was that it provided directly graphs with a non-linear time-base which might be varied within wide limits and, in the instance shown, according to the law $s=\log(1+4t)$; the ordinates were printed automatically, their accuracy being determined by synchronous-clock motors.

In the particular application shown, the recorder was used in conjunction with an apparatus which had been developed to study changes in length of specimens of fresh concrete or mortar during the early stages of setting and hardening. The concrete specimen was cast on grease-proof paper, to reduce restraint to a minimum, and reference platens, supported on ball bearings, moved with the material; the magnitude of the changes in length was determined by means of a mirror extensometer. A typical trace obtained with a concrete mix stored at normal temperatures under drying conditions was shown. At first, there was an apparent expansion, which probably included some settlement, until a peak was reached after 2½ hours; rapid shrinkage then occurred for about 6 hours, after which little further movement was recorded for some hours. The early shrinkage varied considerably, but values up to $1{\cdot}5\times10^{-3}$ were observed.

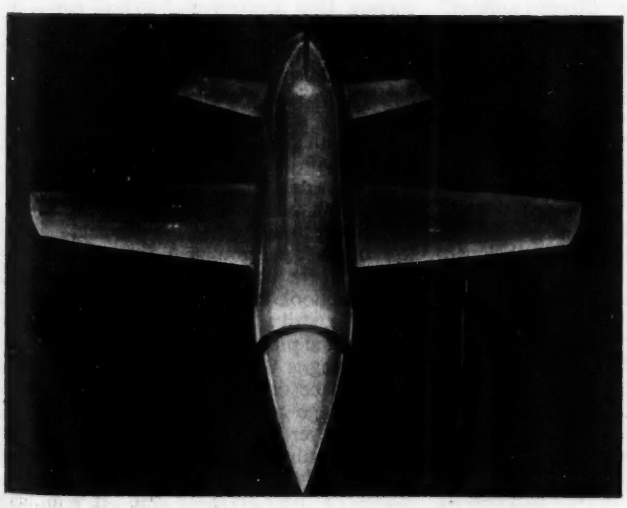
Wind Tunnel Model of the Miles "M.52" Supersonic Aircraft.—With the advent of the aircraft jet engine in 1941, it was clear that flight at supersonic speeds was possible in the foreseeable future. It was known that considerable problems both aerodynamic and structural would arise and, as there was little available data or information available at the time, the Ministry of Aircraft Production placed an order for a research aircraft to investigate, in full scale flight, the problems associated with supersonic speed. Late in 1943, a contract was placed with the firm of Miles Aircraft, Ltd., calling for an aeroplane to achieve a speed of 1000 m.p.h., the engine to be designed by Group Captain (now Sir Frank) Whittle and built by the firm of Power Jets, Ltd.

The engine was completed and successfully tested, but early in 1946, before construction of the airframe was completed, there was a change in official policy and it was decided to cancel the full-size aircraft and to carry out experiments using pilotless rocket powered models of the "M.52." One of these achieved a Mach number of 1·38 and confirmed the calculations made for the original design.

The wind tunnel model exhibited, and shown in the accompanying illustration, was that actually used for the tests at the Royal Aircraft Establishment on which the design of the "M.52" was based. Interesting features in the design were the very thin wings of bi-convex section, the all-moving tailplane and the power-operated controls. The power plant incorporated a ducted fan and afterburning. Although the machine was never in fact completed, the tests with the pilotless models suggested that it could have been the first piloted aircraft to exceed the speed of sound. The model was exhibited by Messrs. D. L. Brown and G. H. Miles.



Erection of a factory structure at Rangoon, using prefabricated space-frame system of roofing



Model of the projected Miles "M.52" supersonic aircraft

Technical Reports

A Stable Synchronous Detector for Audio-Frequency Measurements (Ref. V/T125). By P. G. Kendall, B.Sc. (Eng.). The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Price 12s. 6d., postage 4d.—This report describes the design and performance of a synchronous detector which was developed especially for the measuring system of the E.R.A. network analyser. In this system the detector is used in servo-operated a.c. potentiometers and in electronic wattmeters. The design has to satisfy stringent conditions of accuracy and stability over a frequency range of 100 c/s to 16 kc/s but is otherwise not specialised and may be used in a variety of electronic measuring systems. In particular, synchronous detectors are used as null detectors in a.c. bridge measurements, even when an indication of phase and polarity of the out-of-balance signal is not required, since they do not need retuning for a change of bridge frequency and are insensitive to harmonics and non-synchronous frequencies.

Self-Adjusting Arcs: Drift in Power Source Output and Electrode Feed Rate (Ref. Z/T97). By J. C. Needham, B.Sc. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Price 12s. 6d., postage 4d.—The drift in the output of a d.c. motor generator, on load over a period of half an hour after first switching on and initially set to give 250A, 25V, is determined for three load conditions, namely, constant resistance, constant voltage, and constant current. Drift in the output characteristic is marked with the generator at high open-circuit voltage, but is greatly reduced at low open-circuit voltage due to the reduced drift in excitation. Similar load tests with a transformer rectifier set showed that the output is sensitive to mains fluctuations but that at constant mains voltage drift is negligible. The effect of drift of both power source and of electrode feed rate on arc equilibrium in self-adjusting arcs is discussed and methods of combating it suggested.

LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

EFFECT OF DISTORTION OF A STIFF JOINTED FRAME ON ITS PLASTIC COLLAPSE LOAD

SIR,—We were very interested in Dr. Horne's letter on the above subject which appeared on page 564 of your issue of May 25th. We are not quite sure what Dr. Horne is pointing out with the diagram and relevant comments, but agree that a distorted frame may, very occasionally, withstand more load than when undistorted. This actually occurred at point *C*, Fig. 5. The values of $M_P/2$ we assumed for Fig. 3 were definitely assumed. The deflections may not be due to plastic deformations at the feet, but to elastic deformations of slender columns. The foot moments are then not easily determined. As we demonstrated in Fig. 3, the necessary load for collapse is less in such a case (point *G*). We agree there is some lack of precision in the method given for calculating collapse deflections. Since deflections will be a combination of elastic and plastic effects in all cases, we emphasised that the method was only valid for a first order analysis, for which it is considered adequate, although not accurate. Concerning intermediate collapse mechanisms, we agree they may have no design significance. We felt, however, that their existence should be recognised, and pointed them out accordingly.

J. W. H. KING,
Professor of Civil Engineering,
Queen Mary College.
D. E. JENKINS,
Lecturer in Mechanical Engineering,
Royal Military College of Science.
June 29th.

Literature

Wave Diagrams for Nonsteady Flow in Ducts. By GEORGE RUDINGER. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 45s.

SINCE the theoretical treatment of sound waves of large amplitude by Poisson in 1807, the study of nonsteady gas flows has received the attention of a number of workers. However, it is only during the last two or three decades that this field has become an increasingly important part of fluid dynamics. Numerous diverse technical reports have been published which are unfortunately often difficult to obtain and in which the methods of solution of the fundamental differential equations vary considerably. This book is therefore welcomed as it provides a consistent system of computing procedures and serves both as a valuable introduction to the newcomer to this complicated field and as a convenient reference to those engaged in the use of shock tubes, nonsteady flow gas-turbines, pulse jets, exhaust systems of internal combustion engines, pulse starting methods of supersonic wind tunnels and nonsteady flow in gas lines, to mention a few applications. The solution of a general system of partial differential equations which describe the flow of compressible fluids presents a formidable problem. Simplifications can, however, be made by neglecting terms of small magnitude and in this book, which deals with the propagation of disturbances in ducts, the cross section of the duct is considered small compared with its length, and the independent variables become those of time and space only. The graphical solution of the problem which is based on the theory of characteristics, results in a plot of the propagation of waves in space and time which is known as a wave diagram.

The first chapters deal with the fundamental equations, derivation of the characteristics relations and the procedure for constructing wave diagrams. This is followed by a discussion of general flow problems in ducts of constant and of variable cross sections, flows with variable entropy and with mass removal through the walls. Boundaries and discontinuities and the interaction of discontinuities are then treated. This includes strong and weak shock waves, changes in duct section, supersonic diffusers, flame fronts, collision and reflection of shock waves. The sudden opening or closing of a duct, such as may occur in a shock tube or in the production of a "hammer" wave is also discussed. The final chapters are devoted to the practical application of the aforementioned theories and discussion. Chapter VIII details the techniques of wave diagram construction followed, in Chapter IX, by a valuable set of complete wave diagrams to illustrate the solution of a number of general problems. Included in these is the nonsteady discharge of compressed air from a duct of constant cross section, the shock tube, and interruption of a supersonic flow. A comprehensive bibliography together with useful charts and tables for the construction of wave diagrams complete the contents.

Noteworthy features of the book are the extensive use of descriptive diagrams and the inclusion in the text of a large number of illustrative examples. This is particularly useful to the engineer who will, in general, and in spite of the author's excellent attempts to clarify the multitude of procedures, have to study the book carefully and practise the techniques. The subject is well presented, but in a book where equations are being continually referred to, the designation of which takes the form of chapter number, subsection and equation number, it would have considerably simplified cross reference if, instead of the chapter title at the head of each page, some indication of chapter number had been given. Apart from this the print is large and easily readable and slight errors in equations such as the omission of the primes in equation Eq. (VI.g6) are easily detected. To sum up, there is a definite need for a book of this kind which contains many illustrations gathered from an obviously wide experience and set out in as readable and clear a manner as a subject of this nature will allow.

Micro-Indentation Hardness Testing. By B. W. MOTT. Butterworth's Scientific Publications, 88, Kingsway, London, W.C.2. Price 42s.

EVER since the scientific study of metals and alloys was undertaken, there has been a demand for a test of the relative hardness of localised areas of a metallic surface or of individual constituent particles of an alloy of polyphase structure. The first attempts in this direction involved the use of scratch tests and probably the earliest quantitative measurements were made by Professor T. Turner in 1886. Later, penetration tests under low loads were developed, but it is comparatively recently that micro-hardness testing equipment has become generally available and used to an increasing extent for measuring the hardness of thin sheets, small components of instruments, such as hair springs, case-hardened and nitrided surfaces and surface coatings, as well as of microstructural constituents.

Mr. B. W. Mott has described in this book the instruments available commercially and also those specially constructed in individual research laboratories; and has discussed the precautions which must be taken in carrying out the tests correctly, and the accuracy attainable. Several self-contained bench instruments are described as well as micro-hardness testing equipment which can be substituted for the objective in any microscope. The most commonly used indenters are the Vickers diamond, giving a square indentation, and the Knoop diamond indenter, making a rhombohedral impression with one long and one short diagonal, the Knoop hardness number being derived from measurement of the long diagonal. Those interested in micro-hardness testing as a method of inspection and control may regret that no general standardisation of a micro-hardness test has yet been attempted; but an important chapter is concerned with the relationship between the various hardness scales, and a comparison of the results of various micro-hardness tests with the hardness numbers obtained in standard hardness tests such as the Brinell, Vickers and Rockwell.

Introduction to Plasticity. By ARIS PHILLIPS. The Ronald Press Company, 15, East Twenty-Sixth Street, New York, 10, N.Y. Price 7 dollars.

THIS book has the high quality of finish that distinguishes an American textbook. Unfortunately, the particular volume under review first fell open at pages 68–69, one headed "Introduction to Plasticity—Ch. 3," and the other "Art 3–6, The Movement-Curvature Diagram," and except that the first chapter title and remaining text correctly gave "Moment-Curvature Diagram" the misprint is repeated from pages 51 to 71. Errors of this kind can damn a book unfairly, particularly in this case where the title of the book itself is misleading. The book is concerned with the plastic collapse of structures and not with the general theory of plasticity.

After such a poor start it was refreshing to find an American author giving credit impartially to the pioneers in this field regardless of their geographical situation. Consequently, the book is enhanced by the very broad outlook of its author, who has contrived to strike a very reasonable balance between the protagonists of mathematics and engineering. While the civil engineer will probably be disappointed in that the book does not go very far into the question of design, nevertheless the author has made it clear that the book is primarily for aeronautical, civil and mechanical engineering students at near graduate level. It is in fact a very effective introduction to the subject

and to all the literature that has been published in English so far.

In this country the main interest is on the civil engineering side and centres on the work of Professor J. F. Baker's team at Cambridge. To what extent this book will be overshadowed by Professor Baker's own book, which will be published shortly, is problematical, but it is quite certain that 7 dollars is much too high a price to tempt many English purchasers in the meantime.

Chromium-Nickel Austenitic Steels. By F. H. KEATING. Butterworth's Scientific Publications, 88, Kingsway, London, W.C.2. Price 25s.

THIS book is intended to be of service to the user of chromium-nickel austenitic stainless steels, and is based on the wide experience of Imperial Chemical Industries, Ltd., as a user. While sufficient information is given on manufacturing processes and on theoretical studies of constitution and structure, the emphasis is on properties of value in practical applications of the steels. The mechanical and physical properties of different varieties of these corrosion-resisting steels at normal, high and sub-zero temperatures are recorded. The chapter on corrosion resistance deals with the matter in a fundamental manner, but is supplemented by tables indicating the resistance of the principal types of chromium-nickel austenitic steels to attack by a large variety of chemicals. Fabrication processes and their effect on properties are described, and welding, a very important method of fabrication applied to these steels, is specially dealt with. A defect of the early varieties of austenitic chromium-nickel steels was intercrystalline disintegration, and an account is given of the development of disintegration-proof steels. In this development there has been an extensive use of proprietary names, often covering essentially the same material, but a relatively small number of specifications have been found to meet the needs of industry. A special chapter is devoted to recommended methods of chemical analysis. Chemical engineers and metallurgists will find the data presented to be of great value in making a choice of material and specifying fabrication procedure.

Les Applications Scientifiques de la Notion de la Régularité. By P. VERNOTTE. Publications Scientifiques et Techniques du Ministère de l'Air, No. 307. Paris : Service de Documentation et d'Information Technique de l'Aéronautique, Magasin C.T.O., 2, Avenue de la Porte-d'Issy, Paris (15e). Price 750 francs.

THE author defines "regularity" of a sequence of data at equidistant abscissæ, by means of the sign of successive differences. The conditions given for the signs of these differences are so stringent that they permit the solution of the problem of interpolation and allied questions, simply by expressing the corresponding linear inequalities, the true values being approached quickly and more and more closely without limit. By way of example, the interpolation of factorials is quoted, as this can be checked by means of the gamma function. The same principles apply to the evaluation of physical measurements, a smoothing of the data being obtained within the limits of inherent accuracy without the use of any doubtful procedure. Although the full application of the methods described must await the development of relatively simple but as yet non-existent calculating machines, the procedures outlined already justify the method.

Heat Engines. Fourth edition. By A. C. WALSHAW. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 16s.

"WALSHAW'S HEAT ENGINES" has become a familiar reference to students since its first edition in 1948. The latest version introduces a greater emphasis on consistency in dimensions, a preliminary to the text being an exposition of the Stroud convention for the use of symbols. The author follows common practice in using the pound both for mass and force, but introduces the arbitrary distinction of abbreviating to "lb." in the case of mass and "Lb." for force. Since, in the study of heat engines, kinetics are inextricably involved with fuel consumptions and heat rates, there is, no doubt, justification for the avoidance of absolute units such as the slug. Numerous other amendments have been made, but it may be queried whether the distribution of subject matter between reciprocating and rotary machinery reflects contemporary thought—the section indexed as "Rotary Compressors and Turbo-Compressors" does not illustrate either axial or positive displacement compressors—and also whether it is not time to revise the sentence "Superchargers are always fitted to airplanes and racing cars in which engine-weight per horsepower is required to be small."

The British Civil Engineering Contracting Industry : Illustrated History. The Federation of Civil Engineering Contractors, Romney House, Tufton Street, London, S.W.1. Price £3 3s.

THIS volume contains a display of photographs of civil engineering works and a brief text forming a commentary on the pictorial matter. Many historical works—such as early railways and canals—are depicted, but there is also emphasis on contemporary civil engineering achievements. The book is divided into the following main headings :—Transport and communications, fuel and power, public health, war, and industry. Civil engineering is not, of course, limited to contracting, and so only a partial picture of the civil engineer's work is presented. Nevertheless, the pictorial survey in this volume leaves an impression of considerable achievement, particularly in those sections where contemporary engineering works are dealt with.

A Handbook of Hardwoods. London : H.M. Stationery Office, York House, Kingsway, W.C.2. Price 17s. 6d. net.

IN this handbook there is given a full description of 151 timbers, whilst another sixty-four are briefly dealt with. In addition to bringing up to date the information on hardwood species included in earlier books from the Forest Products Research Laboratory, the handbook covers a large number of other species, many of which are comparatively new to the United Kingdom market.

Information about each timber is given under headings which include seasoning, mechanical properties, wood bending properties, resistance to insect attack, working properties and uses. There is a quick reference table at the end of the book which is intended to be used as a general guide. Kiln schedules are incorporated in an appendix.

The Explosion Danger of Bituminous Coal Dusts. By W. MORSBACH. Paper No. 20, Eighth International Conference of Directors of Safety in Mines Research, Dortmund-Derne, Germany, 1954. Published by the Safety in Mines Research Establishment, Ministry of Fuel and Power, Portobello Street, Sheffield, 1. Price 9d.

IN his paper, Bergassessor a.d. W. Morsbach, of the Berggewerkschaftliche Versuchsstrecke, Dortmund-Derne, raises the question of whether there is in fact a generally valid limit for the fineness of particles beyond which the explosibility of coal dust ceases to increase and again decreases. This question arose from the surprising fact that under equal testing conditions the danger appears to have decreased during recent years. Attempts are made to explain these findings.

Materials Handbook. Eighth edition. By GEORGE S. BRADY. London : McGraw-Hill Publishing Company, Ltd., 95, Farringdon Street, E.C.4. Price 82s. 6d.

THE information given in the new edition of this handbook has been extended and revised and it now gives the essential general data on some 10,000 materials of interest to a wide field of industry. It is pointed out in the preface that its aim is not to provide an exhaustive treatise on any material, but to give general information on materials in their group classifications with descriptions in many cases of patented and trade-named materials, to give a more specific understanding of commercial applications. The second part of the book is designed to provide basic information on the economic geography of materials, resources, weights, measurements, physical comparisons, and other particulars of interest to purchasers.

Rectangular-Polar Conversion Tables. By E. H. NEVILLE. Cambridge University Press. Price 30s.

THIS is the second volume of the Royal Society Mathematical Tables, successors to the British Association Mathematical Tables. Designed primarily for the use of table-makers and others who can avoid incessant interpolation, it gives highly accurate—fifteen-figure—values of r and θ corresponding to integer values of x and y up to 105. Angles are given in degrees, never exceeding 45, and radians ; the natural logarithm of r is also given. An entertaining introduction describing the evolution of the volume, attributes this latter largely to a desire for symmetry in the columns of the table.

Books Received

Basic Technical Drawing. By Henry Cecil Spencer. The Macmillan Company, New York, 10, South Audley Street, London, W.1. Price 30s. 3d.

Radio Electronics. By Samuel Seely. Mc-Graw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 52s. 6d.

Conditions of Contract and Insurance : A Practical Guide for Contractors. By George T. N. Hagart. Witherby and Co., Ltd., 15, Nicholas Lane, London, E.C.4. Price 10s.

A.S.M.E. Handbook—Engineering Tables. By The American Society of Mechanical Engineers. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 90s.

Peaceful Uses of Atomic Energy. Vol. 8 : *Production Technology of the Materials Used for Nuclear Energy.* Sales and Circulation Section, Department of Public Information, United Nations, New York, U.S.A. Price 70s.

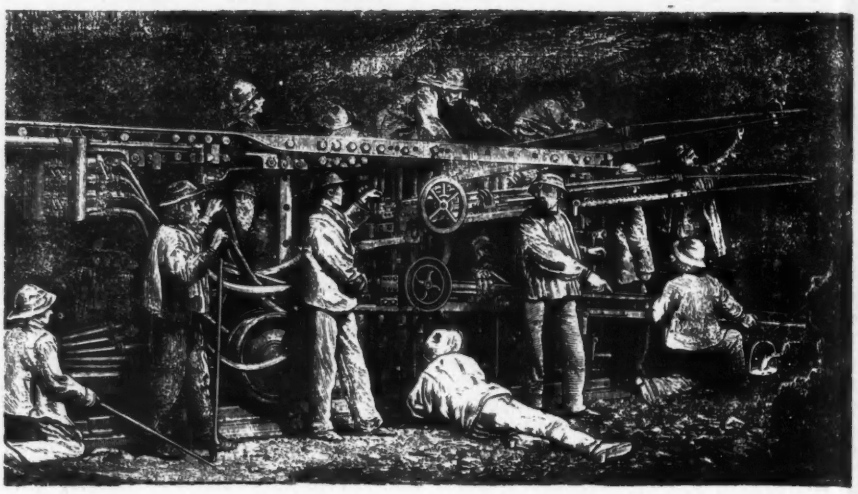
A Handbook on Belt Conveyor Design. The General Electric Company, Ltd., Fraser and Chalmers Engineering Works, Erith, Kent, Price 30s.

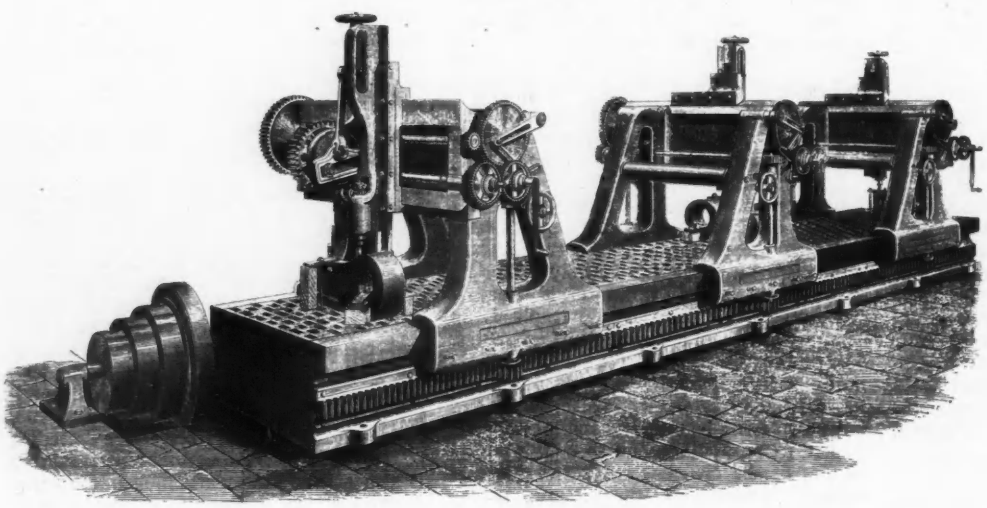
Clock and Watch Escapements. By W. J. Gazeley. George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 40s.

Surveying Instruments and Methods for Surveys of Limited Extent. Second edition. By Philip Kissam. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 43s.

ENGRAVINGS OF 1871

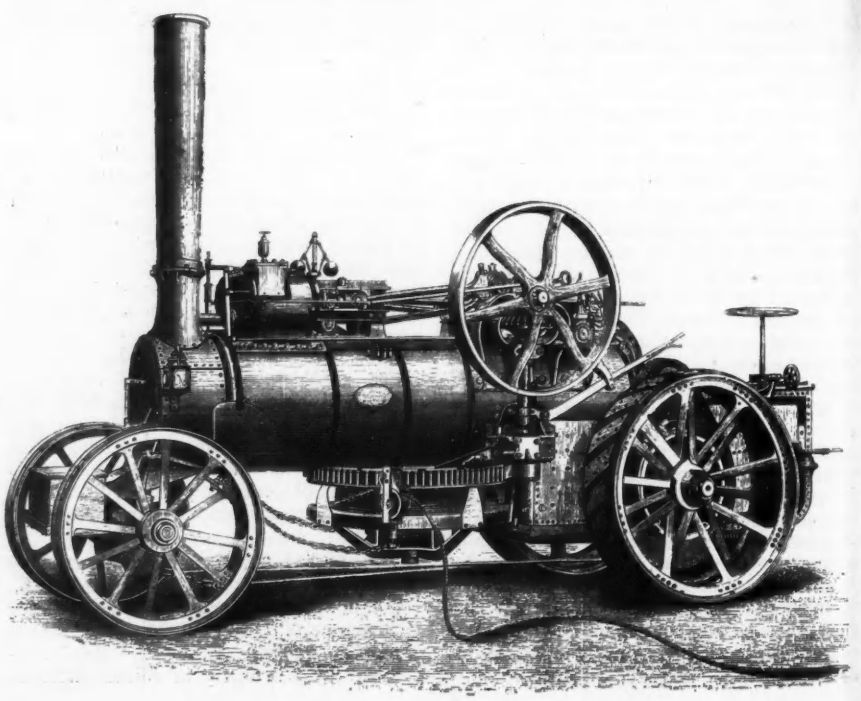
In our issue of October 13, 1871, we printed an article on the Mont Cenis Tunnel, from which this engraving (right) is reproduced. The illustration bears the caption "The Perforatrices at work at the end of the Advanced Gallery." The article on the tunnel says: "the ponderous frame, technically called 'l'affut' supported nine of the machines known as 'perforatrices,' each perforatrice propelled a boring rod, and each boring rod struck the rock at the rate of 200 strokes a minute, with a force of 200 lb. The noise was terrific, but the manner in which the machines accomplished their work was most admirable. In spite of the noise and the cramped positions in which the men necessarily toiled, on account of the limited space, the work went steadily forward day and night. Each man knew his part. Order triumphed in the midst of apparent confusion. One saw then the results of years of perfecting and of practice."





The locomotive frame slotting machine shown in the engraving (left) was made by Fairbairn, Kennedy and Naylor, of Leeds, and described in our issue of December 15, 1871. This machine, it was stated, was "fitted with three slotting heads to finish locomotive frames, 33ft long and 4ft wide, at one setting." Each head had a stroke of 12in, and quick return motion. Machines of the kind were supplied to the North British and Great Eastern Railways.

This engraving, reproduced from our issue of July 21, 1871, illustrates "one of the fine ploughing engines made by John Fowler and Co., Leeds." Our description of it goes on to say: "The cylinders (8in diameter and 12in stroke) are placed near the smoke-box end, steam being taken from the driest part of the boiler. The crankshaft end of the engine is thus turned towards the firebox. By this arrangement the road gear can be constructed exclusively of simple spur wheels, whilst an upright shaft, by means of a pair of bevel wheels and pinion, works the horizontal winding drum, turning on a centre stud beneath the boiler. A self-acting coiling gear guides the rope correctly during the process of winding and unwinding, by means of a lever provided with two guide pulleys. This lever is perfectly at liberty to move horizontally in every direction indicated by the ploughing rope. Thus, perfect freedom is obtained to plough at any angle to the engine which may be required in irregular fields, without giving to the rope an additional bend or unduly straining the coiling apparatus." The weight of the engine in complete working order was 14 tons, and it was stated to be of 14 horse power.



Royal Show at Newcastle upon Tyne

No. II (*Concluded from page 753, June 29th*)

THE Royal Agricultural Society's annual show began on the Town Moor, Newcastle upon Tyne, last Tuesday, July 3rd, and ends this (Friday) evening. This is the first occasion, since the war, that the show has been held as far north as Newcastle, but in whichever part of the country the " Royal " is staged, there is a lively interest in all that is displayed, and a large attendance of visitors from overseas as well as from this country. The impression which we have gathered from a tour of the show on the opening day is that in the industrial regions of the Tyne and Tees there is no lack of interest in agricultural matters. The attendance on the first day was 14,933, compared with 11,726, on the opening day last year when the show was held at Nottingham.

The trade section of the show consists of just under 600 stands. Some of them display such items as feeding stuffs, fertilisers, farm building furnishings and poultry equipment ; but, as is usual, the majority of the trade stands are occupied by the tractor and implement makers and agents. The large section of the show devoted to implements and machinery continues, in this day of highly mechanised farming, to be the one that commands the careful and critical study of most of the visitors. But it is not easy to assess the extent of the business done at the Royal Show ! Over the last twelve months the home demand for tractors and farm machinery has been declining, and overseas demand can best be described as " uneven." The exports, in recent months, of British tractors have fallen, but on the other hand the sale overseas of other farm machinery and implements has steadily expanded. Nevertheless, though the sales situation is more difficult than it was, there is no deterioration in the design and quality of the product.

This year there are fewer new machines and implements to be found at the Royal Show. But there are some in addition to those items which were entered for the Royal Agricultural Society's silver medals. All the well-known tractors are there, including the new models which were introduced at the Smithfield Show in London last December. The particular interest in so far as tractors at the show are concerned is in the improvements that are being introduced to facilitate still further their use with trailed and mounted implements. The Nuffield Organisation, Cowley, Oxon, for example, is showing a tractor equipped with an independent power take-off run directly from the engine. When working power take-off operated machines, such as combine-harvesters or balers, it is necessary sometimes to disengage the tractor drive in order to avoid overloading, or when changing gear. In the Nuffield system there is a second clutch which enables the power take-off shaft and, if necessary, the hydraulic pump, to operate whether or not the tractor clutch is engaged. Thus, whenever the engine is running the independent power take-off will keep the driven implement at the correct operating speed. The twin clutches are built as a unit and are secured to the engine flywheel in the normal way, the clutches being actuated by independent throw-out forks in conjunction with ball thrust bearings. The tractor transmission clutch is controlled externally by a hand lever on the near-side, the power being transmitted by a solid splined shaft to the primary shaft of the gearbox. The drive from the power take-off clutch is by a hollow splined shaft to flanged dog couplings, and thence to a spur pinion driving a gear which is secured to an intermediate power take-off shaft. This shaft extends to the back of the main gearbox and runs in a hollow layshaft. Engagement of the independent power take-off with the output shaft at the back of the tractor is effected by the normal power take-off and hydraulic lever in the usual way.

A piece of tractor equipment which is described as an alternative to the " live " power take-off is exhibited by the David Brown Companies. It is a " constant drive " unit (Fig. 6), which comprises a small wheel carried in a fork and mounted on the hydraulic linkage at the back of the tractor. By means of a secondary linkage the normal upward pull of the hydraulic lift is converted into a downward thrust. Thus, when the hydraulic control lever is applied the offside back wheel of the tractor is raised slightly, part of the tractor's weight being taken by the small wheel and fork of the constant-drive unit. The tractor wheel spins as soon as it loses contact with the ground, and the operation of the differential brings the tractor to a halt without affecting the continuous running of the power take-off drive shaft. On sloping ground the tractor is held stationary by applying the near-side foot brake. It should be noted that the tractor wheel is raised only just enough to clear the ground. Moreover, the makers point out, since the amount of tractor weight supported in this way is less than 10 cwt, the overall stability is not affected and there is no undue strain on the hydraulic pump. When the hydraulic pressure is released, the normal forward motion is resumed without shock to the transmission and the power take-off shaft continues to revolve without there being any variation in speed.

The Ford Motor Company, Ltd., Dagenham, Essex, has recently introduced an automatic pick-up hitch (Fig. 7). It can be fitted to all new " Major " tractors by a simple re-arrangement of the lifting rods and the removal of the top link. In use, the point of pull of this hitch is well forward of the tractor's back axle, a factor which increases adhesion. All trailed implements which are provided with a " ring " hitch on the towbar can be coupled to the tractor without the driver having to dismount. The pick-up hitch locking device is operated by a foot pedal, the spring-loaded mechanism being totally enclosed to prevent it being rendered inoperative by mud or water. The hitch is raised and lowered by hydraulic control and there is a stop on the hook which enables the operator accurately to locate the ring on the towbar of the implement when coupling up. Once the coupling up is effected the hitch is automatically locked and pressure on the hydraulic system is relieved. Incidentally the hitch can be stowed to permit the use of implements coupled normally by the three-point linkage system.

Among the Ferguson tractors exhibited, there is one fitted, as shown in Fig. 9, with reinforced rubber tyre tracks. They are a recent product of Massey-Harris-Ferguson, Ltd., Coventry, and the first sets of the tracks to be made were fitted to the tractors which the firm supplied for the Commonwealth trans-Antartic expedition. Some time ago, it may be recalled, to meet the special requirements of difficult terrain, the Ferguson system of wheel girdles and twin rear wheels was introduced. The new tyre tracks are an addition to that system, the aim being of course to assist the tractive performance of the tractor. In effect, the tyre tracks provide an endless " mat " for the tractor wheels to work upon, which is certainly useful, not only on snow and ice, but on sticky and boggy land where pneumatic tyres alone may not give sufficient adhesion. The tracks, which consist of rubber belts joined by steel cross members, fit over the back tyres of the tractor and over idler wheels connected to brackets beneath the back axle housings. Compression springs are so arranged as to force the idler wheels downwards for adhesion, and forwards to promote the necessary degree of track tension as the idler wheels move vertically and from front to back. There is a hand-operated " throw-over " device which establishes track tension to permit the removal or fitting of the tracks to the tractor.

The machines and implements on the Massey-Harris-Ferguson stand include some new items, two of which are illustrated here. The first of them is a self-propelled combine-harvester, the No. 735 (Fig. 8), which has been designed principally for use on smaller farms. The cutting width of this machine is 6ft, and its width overall is not more than 7ft 7in, so that it can travel satisfactorily along narrow lanes and through

Fig. 6—Constant drive in its travelling position on a David Brown tractor

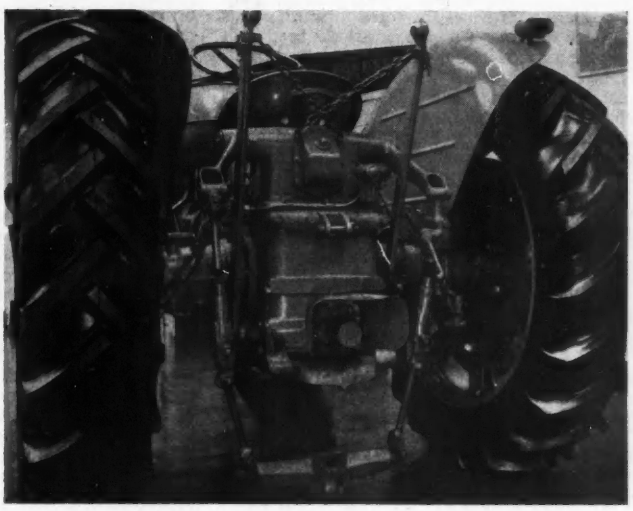


Fig. 7—Automatic pick-up hitch for new Fordson " Major " tractor

Fig. 8—Self-propelled combine-harvester. Its cutting width is 6ft

ordinary gateways. The engine, which is situated on top of the machine, is a vaporising oil version of the Austin four-cylinder 1500 c.c., which will develop 23·5 b.h.p. at 2400 r.p.m. Power to the gearbox from the engine is taken by vee-belt through a conventional speed arrangement. The gearbox provides for three forward speeds and one reverse. The differential has been built into the gearbox, and the drive to the landwheels is taken through the gearbox countershaft to machined internal gears in the wheels. The chassis is a triangular channel steel construction, and the back axle is fully articulated to assist easy travel over uneven ground ; there is automotive steering, the steering track rods being adjustable. In the threshing area of this combine, there are as few working parts as possible ; the grain shaker shoe is fitted with a fixed chaffing sieve, and the fanning mill incorporates a six-bladed fan which can be easily adjusted for controlling the air blast. The threshing cylinder is driven by roller chain, and the concave is of thin steel wire to minimise damage to the grain. The reel, which can be adjusted vertically, has a variable speed drive through roller chain, and the dividers have been designed, it is claimed, to deal equally well with standing or laid crops. Throughout the machine, particular care has been taken over safety ; the bagging platform is near to the ground and is equipped with a safety rail and with screens to protect the operator from moving belts. There are slip clutches at strategic points throughout the machine and there are guard shields at each end of the knife.

The Ferguson mid-mounted industrial mower, illustrated by Fig. 10, is designed to cut grass verges and banks as well as deal with more orthodox work, like cutting common land or recreation ground. Its cutting angles, in fact, range from vertical to 45 deg. below horizontal ; the cutter bar will accommodate a 5ft or 6ft knife, and can be adjusted to any clearance up to 12in. The mower frame assembly is integrated with the tractor body by attachment to the bottom of the differential housing and to the transmission case. The drive to the mower is taken by chain from the tractor's power take-off to a shaft and front-mounted pulley and vee-belting.

One other piece of new equipment shown by Massey-Harris-Ferguson, Ltd., is a tractor-mounted spinner broadcaster for distributing seed or fertiliser. The hopper can take about 5 cwt of basic slag or similar material, and at its base there is a spinner plate which will spread the material to a width of up to 50ft. A slow-speed agitator, which rotates in the opposite direction to the spinner, prevents compaction of the fertiliser or other material being handled, and helps also to maintain an even feed to the spinner. The feed from the hopper is controlled by a hand lever placed conveniently to the tractor driver's seat and the drive to the spinner from the power take-off of the tractor is taken through totally enclosed gearing.

So far we have made little mention of actual tillage implements. At the show, of course, there are numerous examples of all kinds of share and disc ploughs, steerage hoes, and cultivators, the purpose of all of which is to turn the soil and assist the preparation of a suitable seed bed. At every Royal Show which has taken place, Ransomes, Sims and Jefferies, Ltd., Ipswich, has exhibited ploughs. Its display this year includes a variety of tractor trailed and mounted ploughs suitable for work in this country and overseas. In recent years certain of the implements made by Ransomes, Sims and Jefferies, Ltd., have been designed in collaboration with the Ford Motor Company, Ltd., and are designated "Ford-Ransomes." The latest addition to this series is the tractor-mounted subsoiler and mole draining plough illustrated in Fig. 11. The implement comprises a heavy-duty

Fig. 11—Tractor-mounted subsoiler and mole drainer

triangular headstock and a square section, high carbon steel bar which carries the subsoiler. The subsoil standard is mounted on this bar by high-tensile bolts, and its renewable cutter can be reversed end for end ; the "shoe" of the subsoiler is of welded steel and has a renewable steel point. The mole draining attachment can be simply fixed in place of the subsoil shoe ; it consists of a double arm disc coulter which is bracketed directly to the headstock in front of the subsoil standard. Effective mole draining to a depth of 18in is claimed for the implement. Altogether, Ransomes, Sims and Jefferies, Ltd.,

Fig. 9—Reinforced rubber tyre tracks for Ferguson tractor

Fig. 10—Mid-mounted industrial mower

Fig. 12—Tractor-mounted " Agrotiller " with a working width of 3ft 4in

is exhibiting about forty examples of its implements and machines.

Our last illustration, Fig. 12, is of an " Agrotiller," which is exhibited for the first time at the Royal Show by Frank Bonser and Co., Ltd., Hucknall, Nottingham. The hoe-shaped blades attached to the rotor are made of high-grade steel and the machine illustrated is mounted on the hydraulic lift of a Ferguson tractor ; it has a working width of 3ft 4in. The firm is showing some other models of this machine which can be mounted on tractors of 30 h.p. to 45 h.p. ; their working widths are 4ft 2in and 5ft. In all the mounted models the method of operation is similar. Transmission from the tractor power take-off is through double universal joints, safety clutch and bevel gearing, and the final drive to the rotor is taken by roller chain. All the gears and chains are totally enclosed and run in oil. The cutting depth of the blades is adjustable to a maximum of about 8in.

Electrical Exhibits

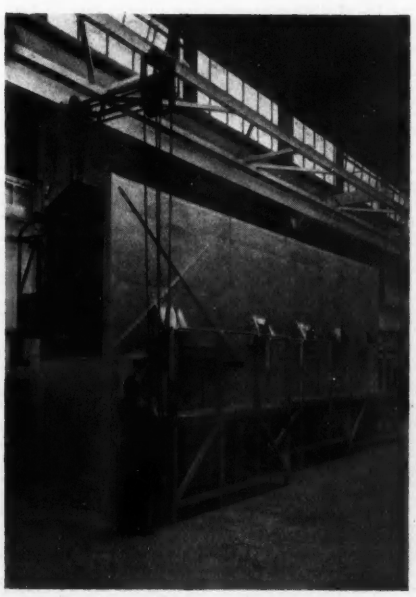
In this very general survey of the show we can do no more than make a brief reference to the electrical exhibits. The British Electrical Development Association has assembled what can well be described as an " exhibition within an exhibition." It is entitled " The Electricity Farm " and demonstrates effectively the many spheres in which electrical power can be economically used in a mechanised agriculture. The same theme is emphasised in the exhibits of the electrical appliance manufacturers. The exhibits of The General Electric Company, Ltd., include a fluorescent lighting fitting for use in seed potato chitting houses, and also electrical equipment for glass house heating, plant irradiation, soil sterilisation and soil warming. On the stand of the British Thomson-Houston Company, Ltd., there is shown the " Stayrite " a.c. single-phase power drive which is available in sizes of 2 h.p., 3 h.p. and 5 h.p. The " Stayrite " equipment consists of two components, namely, the motor and its associated starting equipment. The motor is a foot-mounted machine for which there is claimed a good starting torque with a low starting current. The makers say that the starting current is only 1·5 times the normal full-load current ; the 2 h.p. and 3 h.p. motors develop 75 per cent full-load torque at starting, while the 5 h.p. unit develops 60 per cent. The air-break starter is hand-operated and has under-voltage and over-current trips. It also has a correct sequence device which ensures that the operating handle is moved into the " start " position before being moved to the " run " position. These " Stayrite " equipments are suitable for use on 230/240V, 50 cycle, single-phase circuits.

Silver Medal Awards

When the show opened on Tuesday morning, the Royal Agricultural Society announced this year's awards of silver medals for new implements. These awards have been made to : H. Leverton and Co., Ltd., for a bulb lifter fitted to a Lanz tool carrier ; Atkinson's Agricultural Appliances, Ltd., for a power-operated silage cutter ; T. T. Boughton and Sons, Ltd., for a tractor-mounted winch ; Gascoignes (Reading), Ltd., for electronically controlled milking equipment ; and to Scottish Mechanical Light Industries, Ltd., for an instantaneous moisture meter which measures the moisture content of grain in bulk and in sealed sacks, without the necessity of sampling. The equipment consists of a nine-prong probe and an ohm-meter with built-in 500V generator. The bulb lifter, the silage cutter and the winch were described in our last issue.

Cleaning Process for Castings

The manufacturing rights of the Kolene cleaning process for castings have been acquired from the United States by Castingite, Ltd., and a demonstration plant has been installed at that firm's works in Stone Yard, Deritend, Birmingham. This process is intended for cleaning iron or steel castings of sand, rust, grease and scale, in readiness for machining, plating, enamelling, brazing, soldering, white metalling, or other operations calling for clean, uncontaminated surfaces.



Salt bath end of plant for cleaning castings by the Kolene process

Primary cleaning of the castings is carried out in a bath of " Kolene 4 " salt, which is a hygroscopic alkali base material containing natural salts which act catalytically when activated electrically. In an electrically activated, catalysed, molten oxidation or reduction bath, the chemical reactions are produced and controlled electrically to clean the surfaces of the castings. The electrical energy for activating the bath can be supplied by a 6V to 8V d.c. source of suitable amperage for the size and volume of the work to be processed. One lead from the d.c. source is connected to the salt bath and the other to the work basket, which is immersed in the bath. The bath is heated to about 450 deg. Cent. by any suitable means.

When it is required to remove sand, scale, rust and other oxides from ferrous castings, a reduction cycle is used—the negative lead being connected to the work basket and the positive lead to the bath. To prepare work for soldering, tinning or white metalling an oxidation cycle is used, the positive lead being connected to the basket and the negative lead to the bath. This cycle removes oils, greases, organic materials, sulphur, phosphorus, graphite and carbon from the work surface. It is a quick and easy matter to change over from one cycle to the other whilst the work is immersed in the bath by the introduction of a change-over switch in the current supply circuit.

A typical cleaning plant being demonstrated at the works of Castingite, Ltd., is illustrated on this page. It consists essentially of a group of three tanks—the salt bath, a cold water rinsing tank, and a hot water rinsing tank—with a suitable fume-exhausting hood and an overhead runway for supporting and transferring the work baskets between the tanks. In the cleaning process a basket of castings is lowered into the salt bath, where the circulation of molten salt removes all the scale, sand, rust and other oxides which gravitate down into a sludge pan at the base of the tank. At the end of the predetermined cleansing period the basket is raised and transferred into the cold water tank, where any adhering salts are washed off. The work is finally rinsed in the hot water tank and when the castings are afterwards removed they retain sufficient heat to dry very quickly.

The makers point out that a plant of this kind can be built with suitable conveyor equipment for the automatic transfer of a series of work baskets between the tanks to give a continuous cleaning cycle. The process can also be used for paint stripping, the descaling of stainless steel strip, and other forms of cleaning, by the use of different kinds of Kolene salts.

Finlarig Power Station

The North of Scotland Hydro-Electric Board held an opening ceremony last Saturday at the Finlarig power station of the Lawers scheme, in north-west Perthshire. The station was opened by Lady Taylor, wife of the Principal of Aberdeen University. Finlarig power station was, in fact, first brought into use towards the end of last year ; it has one main generating set, which is the only sizeable Pelton wheel set so far installed on the Board's works. The installed capacity is 30MW, and the set has a horizontal shaft with two turbines, operating under a gross head of 1362ft. The estimated average annual output of the station is 80,000,000kWh. The reservoir of the Lawers scheme is formed by a massive buttress dam, similar in shape to the Loch Sloy dam, with a height of 130ft. The consulting engineers for the scheme are James Williamson and Partners, and Merz and McLellan ; the main civil contractor is the Cementation Company, Ltd., and the generating plant was supplied by the British Thomson-Houston Company, Ltd. The Lawers scheme is the first stage of a comprehensive development involving a number of neighbouring catchments—the Breadalbane scheme—where construction is active at the present time.

Experimental High-Speed Launch

THE demonstration trials of the experimental high-speed rescue/target-towing launch "2762E" were held last month, and our first illustration shows the launch at speed. This craft was designed by Vosper, Ltd., for the Ministry of Supply and was intended primarily to operate as a floating test bed for the first pair of Rolls-Royce "Sea Griffon" Mark 101 engines. However, the hull is also an experimental structure, being of hard chine form, having framing, longitudinals, bulkheads and bottom plating, &c., of aluminium alloy, all-welded by the "Argonaut" and "Argonarc" processes, with a glass fibre skin above the chine. The aluminium alloy plating is to standard specification N5/6, and extrusions to N6, and the glass fibre topside skin panels, which are in one length, were manufactured by Halmatic, Ltd., and bolted to the framing. This construction represents a complete change from general practice, since wood has hitherto been the building material used for this class of boat. Slamming is normally associated with the hard chine form but the lines adopted by the builders have resulted in a considerable reduction of slamming in a head sea, while retaining the characteristics necessary for planing.

The launch has a length of 68ft, a moulded breadth of 18ft, and a moulded depth of 8ft 5in, and the maximum speed is between 40 to 42 knots, while the range is 570 miles at 37 knots. Accommodation is provided for one officer, a crew of seven and for nine in the sick bay. Below deck the hull is divided into seven compartments by six watertight bulkheads. Immediately aft of the forepeak is the crew's toilet, storage space and a lobby which has access to the deck through a watertight scuttle and from which a watertight door leads to the crew's quarters. Here there are four berths and four pipe cots and a compactly planned galley. A vertical ladder gives direct access to the wheelhouse and a watertight door in the aft bulkhead opens into the sick bay, which is fitted with three berths and six stretchers and has a companionway at the aft end which leads to the deck immediately abaft of the deck-house. The space aft of the sick bay is occupied by the fuel tanks, which are of 12 S.W.G. aluminium alloy sheet and welded, there being two wing tanks of 731·5 gallons capacity and a centre tank holding 760 gallons. Continuing aft, there is the engine-room which houses the two Rolls-Royce "Griffon" engines and auxiliaries. At the forward end of the space, on the centreline, is a control room having access to the deck by way of a sliding canopy and there is a similar access arrangement at the aft end of the engine-room. In the aft peak compartment are installed the target-towing winch and battery boxes. There is a small wireless telegraphy office in the deck-house and accommodation for the commanding officer, placed immediately abaft the wheelhouse, which incorporates a raised open conning bridge.

Heating of the craft is by a Smith's type 50 A.S.M. unit having a capacity of 50,000 B.Th.U. per hour. Navigational aids include a Decca radar and a plan-position-indicator, and the radio installation consists of a set for high- and medium-frequency working, a ten-channel set for very high frequency working and a radio compass. Also fitted is "Sarah" radio rescue equipment and a short range radio telephone.

The "Sea Griffon" Mark 101 engine is a development of the "Griffon 57" aero unit and is basically a 60-deg. vee engine having twelve cylinders of 6in bore by 6·6in stroke with a maximum output of 1450 b.h.p. at 2400 r.p.m. The second photograph reproduced below shows the engines and exhaust piping. Each engine is fitted with a reversing gearbox, based on a Mathway design and built by Rolls-Royce, Ltd., and incorporating single lever control, the synchronisation of the gear change and engine response being hydraulically controlled. The transmission of power to the propellers is through a Vosper vee drive, with a reduction of 1·54 to 1, there being "Metalastic" flexible couplings connected to toothed couplings fitted between the engine and the vee-drive. Cutless rubber bearings are fitted in the stern tubes and shaft brackets. Cooling of the engines is by a closed fresh water circuit, the fresh water being cooled in a sea-water circulated heat exchanger. Exhaust gases are discharged at the transom, the gases passing through water-jacketed copper pipes in the engine-room and rubber pipes in the aft peak, the water circulated round the jacketed pipes being discharged into the rubber pipes. The control booth is insulated and houses the controls and instrumentation, which are grouped in one panel per engine. A duplicate set of instruments and emergency magneto cut-out switches are mounted in the wheel-house. Mention has been made already of the single lever control of throttle and reversing gear, and the transmission from the wheel-house to gearbox is by "Bloctube" rods and levers. Electrical power is provided by two 2½kW generator units driven by 6 h.p. Norman air-cooled petrol engines and by eight 6V, 220Ah batteries connected in series-parallel to give an output of 24V, 460Ah.

Combined Continuous Backing Bar and Clamp for Cylindrical Welding

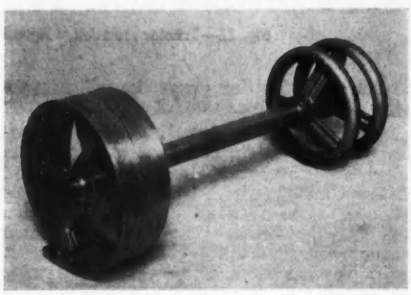
WHEN it is required to weld together hollow cylindrical sections or pipes circumferentially considerable difficulty is often experienced in ensuring correct alignment whilst at the same time providing effective clamping of the parts. This is particularly true when it is necessary to match with some degree of precision such things as sections of large, thin vessels of aluminium or stainless steel, where the grinding-off of internal weld steps must be kept to a minimum and plate thickness must be maintained at the weld line. To obviate these difficulties a new design of continuous backing bar incorporating an effective clamping means, has been developed by Yates Plant, Ltd., Whidborne Street, London, W.C.1, and we are informed that bars can be made for welding vessels from 4in to 10ft diameter.

One form of the new combined backing bar and clamp can be seen in the accompanying illustration. The backing bar of copper or special grade iron consists of a closely coiled cylindrical helix. Two groups of four brackets evenly spaced round the inside of the coils are each connected through links to a pair of internal spiders carried on the ends of concentric tubes. Hand-wheels at the far ends of the tubes can be turned in opposite directions to rotate the spiders, and through their links expand or contract the coils of the backing bar over a predetermined range.

When using the equipment the backing bar is contracted by operation of its handles and inserted in the abutting cylinders with about half of its width on each side of the proposed circumferential joint. On the handles then being released, the bar expands to hold the cylinders firmly and a strong mechanical clamping effect can then be applied by further rotating the handles to expand the bar. A shallow annular groove is formed round the backing bar to permit complete penetration of the weld without danger of blow-through.

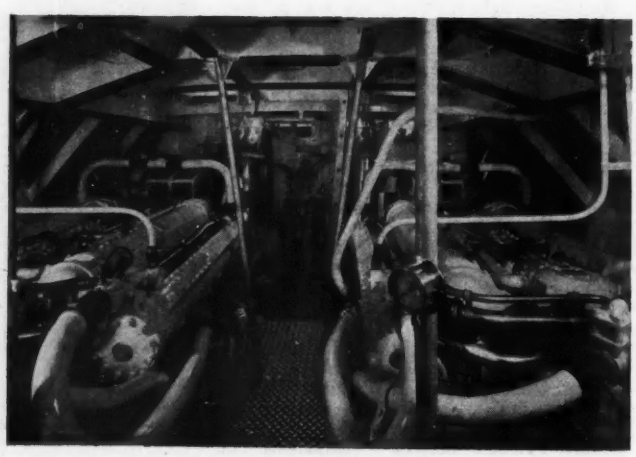
The maker points out that the supporting and control tubes for the backing bars can be made in various lengths to suit the class of work and on the larger sizes alternative manually-and power-operated means can be provided for holding the bar in its contracted and expanded conditions. The backing bar is capable of conforming to a degree of ovality in pipe work, and in such cases compensation for ovality is provided by the curved toggle links used in the smaller sizes acting as resilient push members, and by the telescopic effect of the push rods used in the larger sizes. Alternatively, in heavy gauge pipes, ovality can be corrected by the expansive force of a combined toggle and screw operating mechanism with straight push links which is used to expand the backing bar.

In work calling for the use of "Argonarc" or inert gas welding this design of backing bar provides a useful means of introducing the gas at the back of the weld. In such cases the gas can be introduced at the handle end of the inner



Prototype continuous backing bar for circumferentially welding cylindrical vessels

High-speed rescue/target-towing launch "2762E" on trial



Engine-room with "Sea Griffon" engines as seen from control booth

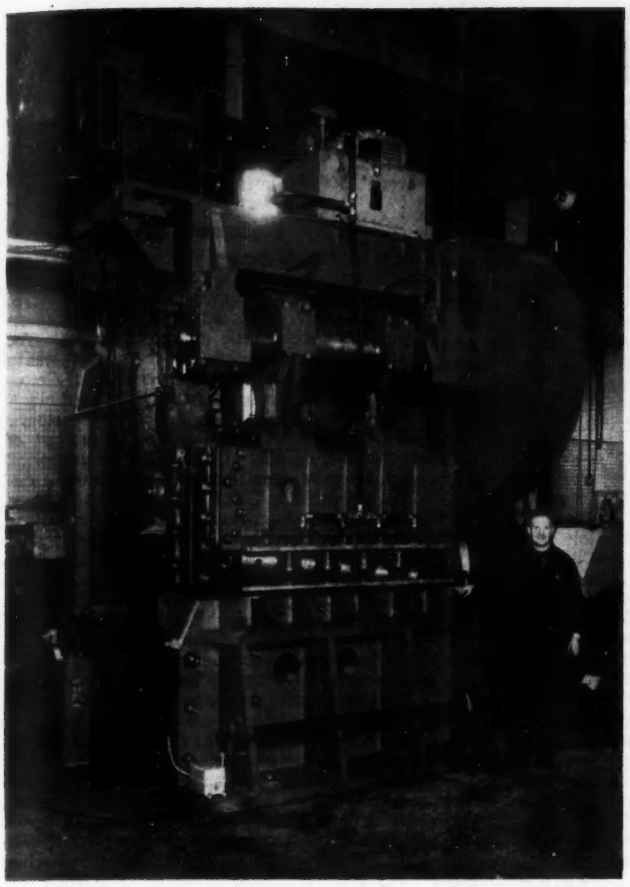
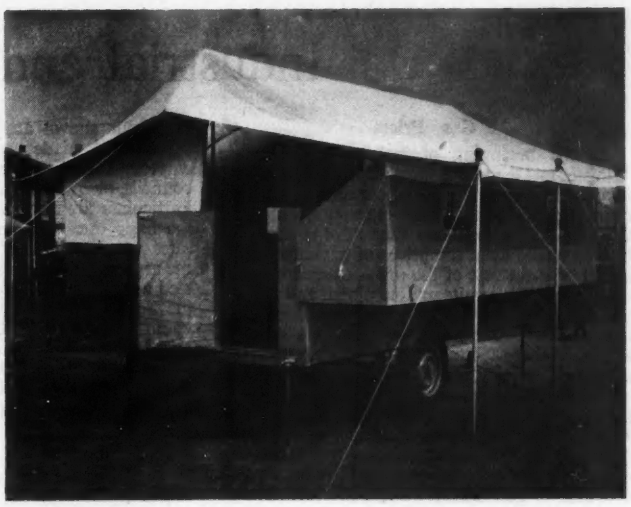


Plate shearing machine for 45-ton steel plates up to 1½in thick and 3ft wide



The caravan unfolded and with fly-sheet erected. It weighs 17 cwt

control tube and carried through flexible tubes at the operating end to an annular groove or recess in the surface of the bar immediately adjacent to the joint.

The smaller sizes of the equipment have hard drawn copper backing bars which can be machined on the periphery for Class I welding, there being sufficient material for repeated skimming up on a lathe from time to time. The larger sizes have steel-channel or tee-section backing bars fixed with replaceable copper segments.

Heavy-Duty Plate Shearing Machine

We illustrate on this page a new heavy-duty shears with a capacity for shearing 45-ton, tensile steel plates up to 1½in thick and 3ft wide which has been built by the Bronx Engineering Company, Ltd., Lye, near Stourbridge. It has a clear width of 4ft 3in between the frames, but the blades are long enough to permit shearing of longer lengths of plate of any length and a width of 18in, governed by the 18in gap in the frames. The blades are each provided with two cutting edges to give full-face contact of the flat face to the top and bottom shear beam and bolster respectively.

The machine is driven by an 80 h.p. motor through vee belts, a fly-wheel and double reduction gearing; its rated speed being fifteen strokes a minute. Drive is transmitted by a hydraulically operated multi-plate clutch and a caliper brake, which is fitted to the flywheel shaft, is interlocked with the hydraulic system and a timing cam. Hydraulically operated hold-down pads fitted on the machine are supplied by an integral "Towler" motor-driven pumping set mounted on top of the bridge. The upper beam moves in "Tufnol" lined slides in the side frames.

Cantilevered Stand Roof

An interesting constructional item of the newly-completed stand at the Cardiff Arms Park Stadium is the cantilever aluminium-clad roof, which was designed by W. S. Atkins and Partners. The major part of the stand roof, 337ft long and 66ft wide, stands out over the crowd without apparent support, and with no roof pillars further forward than 16ft from the back of the stand, gives a clear and uninterrupted view of the whole field of play. The steel supporting structure incorporates tension members at the back of the stand and they balance the overturning moment of the cantilever. At the same time a significant contribution to the lightness desirable in a roof of this pattern is made by the roofing material, which is corrugated aluminium sheet of 20 S.W.G. (0·036in), supplied by Northern Aluminium Company, Ltd. This material is not only light but by reason of its deep-ridged design, is strong enough to cover wide spans and this enabled the steel purlins to be placed at 8ft to 8ft 6in centres, with a consequent reduction in the weight of steel required compared with that necessary to support other covering materials of similar weight but of less strength.

The alloy used for the corrugated sheeting is claimed to be able to resist atmospheric attack, even in the industrial atmospheres of the Cardiff area, without a protective coating of paint, thus effecting a considerable reduction in maintenance costs. The sheeting is able to withstand with safety a load of 200 lb on a 5in square, so that no special precautions are necessary for walking over the surface of the roof. To keep the shadow effect on the playing area as small as possible, an extremely flat roof-pitch, a fall of only 1 in 60, was used, and to prevent leaks the sheets were given a 9in end lap, and the joints were sealed with mastic.

Underside of aluminium clad cantilever roof at Cardiff Arms Park stadium

Folding Caravan

Four folding caravans have recently been shipped to Turkey by the Shell Petroleum Company for use on oil survey and exploration. Built by the United British Caravan Company, Ltd., West Drayton, Middlesex, each can be towed easily by a Land Rover, and has Rover wheels and Girling overrun brakes. When closed for towing, the body resembles a box 15ft 6in long and 6ft 6in wide. When unfolded, it is 10ft 7in wide and gives an internal head-room of 6ft 3in. The erection takes only quarter of an hour, a folding ridge pole carrying five spring steel ribs, which shape a half-elliptic canvas roof; a fly sheet gives additional protection. The sides, when open, are supported by struts which, as can be seen in the illustration, are captive and lie against the sides when folded. There is a flexible edge seal along the junction between fixed and folding parts of the body. The body is flush panelled inside and out with resin-bonded plywood.

Two tables are provided inside, and Dunlopillo seating on the sides can provide beds for four or even six persons. They are intended to function either as offices or living quarters.

The same manufacturers are preparing for use by Shell in Nigeria and Pakistan some particularly elaborate vans scaling 35 cwt each. These will each have a 1 h.p. air-cooling and humidifying unit mounted over the towbar, and will be fitted with flush lavatories and shower baths. Expanded bronze sheets form the fly screens, while the body is sheathed in chromate-treated aluminium and does not require to be kept painted. The walls include a 2in cavity packed with glass fibre.

Industrial and Labour Notes

Gas Prices

At the beginning of last week the Prime Minister met leaders of the nationalised industries for a discussion of matters concerned with the economic situation. Following that meeting, the Gas Council announced that all the area gas boards would keep the prices of gas unchanged, at least for the rest of the present financial year, unless something quite unexceptional and unforeseen occurred to frustrate that intention. In making this announcement, the Gas Council explained that each of the twelve area boards has the individual duty, imposed by Act of Parliament, of making its expenditure and income balance. Increased costs, when they had reached a stage where they could not be absorbed by improved efficiency or internal economies could only be met by adjustments in the price of gas or of other products of gasmaking. Thus, the intention to stabilise prices becomes effective after the area gas boards have made such revisions as most of them find necessary to meet increased working costs as at June 1st, including the latest increase in the price of coal.

Engineering Wages and Hours

In these notes in our last issue we recorded the rejection, by the Shipbuilding Employers Federation, of a claim for a forty-hour week in the shipbuilding industry, which had been put forward by the Confederation of Shipbuilding and Engineering Unions. On Thursday of last week, a similar claim on behalf of workers in the engineering industry was rejected by the Engineering and Allied Employers' National Federation.

The claim included increased holiday pay as well as a forty-hour working week. After the rejection of the claim by the Engineering and Allied Employers' National Federation, its president, Mr. F. C. Braby, said that wage increases throughout industry had added to costs in engineering by over 12 per cent since January 1955. His view was that wage stability was the only hope of maintaining full employment in the engineering industry which was having to face an ever-growing demand from overseas customers for fixed prices. But Mr. Braby emphasised that an "embargo" on wage increases generally did not mean, of course, that earnings could not rise with productivity. The engineering industry, he said, believed in payment by results.

Changes in Wage Rates

The Ministry of Labour has stated that changes in wage rates in the United Kingdom, which became effective in May, resulted in an aggregate weekly increase of £412,000 in the weekly full time wages of about 985,000 workpeople. Among those who received wage increases in May were merchant seamen, certain engineering, supplies and motor transport grades in the General Post Office, and some craftsmen employed in general printing. Workers engaged in paper and paper board making also received increases. The Ministry's statement shows that, in the first five months of this year, changes in wage rates resulted in 10,970,000 workpeople receiving an aggregate weekly increase of £5,547,000. In the comparable period of last year there was a net increase of £3,924,000 in the weekly full-time wages of 9,982,000 workpeople. During May, the index of rates of wages (June 30, 1947=100) moved up a point to 164, for all workers. At the end of last year, the index was 154.

Time Rates of Wages and Hours of Labour

The Ministry of Labour has announced the publication, by H.M. Stationery Office, of the tenth edition of *Time Rates of Wages and Hours of Labour*. The principal tables in this new edition show, for this country's more important industries and occupations, the minimum or standard time rates of wages, the dates from which they became operative, and the normal hours of working.

It is explained that the rates of wages and hours of labour shown are those fixed by voluntary agreements made between organisations of employers and workers, or by joint industrial councils, or by statutory orders under wages acts. Particulars are also included, where available, of the basic rates for pieceworkers, the additional rates payable to shift and night workers, and the arrangements, where they exist, for a guaranteed weekly wage. There are three appendices to the book showing details of rates of wages for young workers in a selection of industries, and of overtime rates and the arrangements for paid holidays in those industries mentioned in the main tables of the volume. In general, the information relates to the position as at April 1st last. The price of the book is 9s.

Directing Research Establishments

The Department of Scientific and Industrial Research has announced that an international symposium on "The Direction of Research Establishments" is to be held at the National Physical Laboratory, Teddington, from September 26th to 28th. It is intended for those whose special responsibility is in the direction and management of large research establishments, whether government or industrial. The symposium will begin with a session covering some of the general problems of the direction of research. This is to be followed by group discussions, running simultaneously, on problems of staff, general organisation and communication. The results of these discussions will be integrated in a plenary session and followed by a session on the assessment of the work of a laboratory. This forthcoming symposium is believed to be the first international conference on science administration held in this country at which representatives of industry and government organisations will be able to exchange their experiences.

Price Stabilisation

In the House of Commons on Thursday of last week, the Prime Minister, Sir Anthony Eden, was questioned as to what the private sector of industry was doing in the matter of price stabilisation. Mr. Gaitskell, the leader of the opposition, suggested that an "impossible situation" would be created for the nationalised industries if, after they had pledged themselves not to raise prices, prices continued to go up in the private sector, thus putting up costs for the nationalised industries.

In his reply, the Prime Minister recalled that certain steps had been taken by private industry at an earlier stage. The Government, he added, had already stated its intention of continuing to maintain contact both with the Trades Union Congress and with employers' organisations in private industry. He hoped that still more progress would be made in the efforts to secure price stability.

Velindre Tinplate Works

The Steel Company of Wales, Ltd., recently organised a press visit to show the latest developments in the steel division at the Abbey works and the progress made in the construction and equipping of the new tinplate plant at Velindre. Work started on the Velindre plant in 1953 when it was planned to receive pickled coil from the Abbey works and process it up to and including the black plate stage. Later it was decided to extend the plant by the addition of three electrolytic tinning lines, and this was planned as the second stage in the construction programme.

The main plant to be installed at Velindre includes the following: a four-high, 42in wide, five stand cold reduction mill; two electrolytic cleaning lines; a continuous annealing furnace; seven batch annealing furnaces; two four-high, 42in wide, two stand tandem temper mills; three tinplate shearing lines; and three electrolytic tinning lines. Installation has been almost completed of the cold reduction mill, one cleaning line, three batch annealing furnaces, one temper mill and one shearing line, and it is expected that production with this equipment will begin in a few weeks. It is expected that the remainder of the equipment will be ready for operation next year and it will then be capable of producing some 9,500,000 lines a year.

Profits and Trade

At the annual general meeting of Guest, Keen and Nettlefolds, Ltd., which was held at Birmingham on June 28th, the chairman, Mr. K. S. Peacock, said that future trading prospects generally were a little difficult to assess. The essence of a good business, he maintained, was to make a good profit, though the essential factors of such profit earning must surely be fourfold.

First, Mr. Peacock continued, the customer must be efficiently served with a product of satisfactory quality at a fair and proper price, and, secondly, there should be a fair and reasonable wages policy. That, however, did not mean approval of the methods of some unions in exploiting the present labour shortage by repeated applications for increases in wages. Some further and very serious attempts must be made, Mr. Peacock urged, to arrive at a better *modus vivendi* between unions and employers and new agreements for wage increases should last for much longer periods. Further applications should not then be brought forward unless tied to a corresponding increase in production. Thirdly, Mr. Peacock observed, an adequate return should be made to the stockholders who "provided lifeblood in the way of capital," and, fourthly, he said, profits must allow the retention each year of the large sums essential to finance the modernisation of buildings and plant.

So far as the Guest, Keen group was concerned, Mr. Peacock said, the higher production level in 1955 and the greater efficiency with which the plants were operated enabled many increases in cost to be absorbed. But in the case of raw materials there had been no option but to pass on the increased cost to the customer. With most of the group's plant operating near capacity, there could be only limited room for improvement in the profit ratio, whilst on the other hand it could be greatly reduced by a fall in volume of turnover.

National Inspection Council

Shortly after vesting day the British Electricity Authority, with the support of the Area Electricity Boards and other interested associations, proposed that the existing National Register of Electrical Installation Contractors should be reorganised on a wider basis, to include an extended inspection service and be renamed the National Inspection Council for Electrical Installation Contracting. An organising committee was set up in 1950, and submitted a preliminary report in 1952, but unanimity on the decision to set up the Council was not achieved until two and a half years later. The organisation as accepted is a two-tier body having the National Board as the executive consisting of sixteen members drawn from various technical interests on the organising committee. As announced earlier this year, the Board of Trade has approved the formation of the National Inspection Council, of which Mr. P. V. Hunter is the first chairman and Mr. C. R. King is the deputy chairman. The central body is the National Council, which will meet annually and consists of representatives of the national bodies, interested both from the technical and consumer aspects. It is hoped that the large number of interests represented will promote country-wide interest in the work of the Council. It is proposed to set up local committees, one for each Area Board, consisting of representatives of trade unions, representatives of the Area Boards and private contractors, and of local consumer interests. To have an appreciable influence 7000 inspections per annum are considered to be a minimum and will require the services of twenty inspectors. Enrolment rules have been drafted and future admissions to the roll will require the approval of the Inspection Board.

Eighth Annual Report of U.N. Technical Assistance Board

THE report prepared for submission to the Technical Assistance Committee of the Economic and Social Council, was released at U.N. headquarters on June 5th. It describes developments under the programme during 1955, with some details on 1956 activities and brief indications of plans for 1957.

During 1955, 101 countries and territories received assistance in some form and approximately 1400 international experts were working at the end of the year to promote better living conditions through improved agricultural and industrial production, health education, public administration and communications.

Recorded obligations for the year totalled 25·8 million dollars, representing the highest level in the five years for which the programme has been in existence. Total contributions from seventy-one governments, amounted to 27·9 million dollars, as compared with 25 million dollars in 1954.

This volume of assistance rendered by the U.N. and the seven participating specialised agencies* is stated to be small in relation to the priority requirements of the less developed countries. Technical assistance projects formed part of larger national development plans executed by governments and it was not, therefore, possible to isolate the impact of U.N. technical assistance on the economic development of assisted countries or to measure it in precise terms. Nevertheless, certain examples may serve to illustrate the scope of the programme and some of its accomplishments to date.

In Yugoslavia, expert assistance resulted in doubling one plant's output of cylinder blocks for internal combustion engines, and in reducing production costs at an electrical equipment factory by more than 50,000,000 dinars a year. In Jordan, production of phosphate from the Ruseifa mines has been raised from 2000 tons per month to 20,000 tons. Venezuela has been helped to establish what will eventually be the largest fertilizer and insecticide factory in South America. In the farm mechanisation plan of the State of Uttar Pradesh in India, some of the field workshops have increased their output by nearly 300 per cent and more than 500 instructors and operators have been trained by international experts.

In East Pakistan work is proceeding on a pilot irrigation area of 230,000 acres on the right bank of the Ganges, where approximately one-fifth of the main canal has been excavated with the assistance of the International Co-operation Administration and the Colombo Plan; it is expected that irrigation water will be available in the Kushtia area by the end of the present year. In Egypt programmes for increasing wheat and rice production have been undertaken and in Ethiopia a development scheme for coffee cultivation has been started. Cotton cultivation trials in Yugoslavia have given a substantially increased yield per acre. In Central America and Mexico, technical assistance experts have helped the local authorities to keep the locust plague under control everywhere but in Northern Honduras. Supplies of vaccine to control animal diseases have been built up in Afghanistan, Austria, Burma, Ceylon, Ethiopia, Honduras, India, Iraq, Pakistan, Thailand and Yugoslavia.

In Colombia, an educational programme of radio broadcasts has been started. In Somaliland the education of nomads is being introduced. In Haiti, over 1000 rural teachers attended courses. Technical assistance helped the Government of Burma to launch a social security scheme, assisted Iran in the adoption of a new social insurance law, and Mexico and Turkey in establishing training centres in labour administration.

During the year about 500,000 persons were treated for Trachoma in Morocco and Tunisia, and a high percentage of cures has been reported. Epidemic malaria is no longer prevalent in about half of the island territories of the Caribbean and about two-fifths of the estimated population of South East Asia now benefits from anti-malaria preventive measures. In India, it is estimated that over 40,000,000 people have been given at least some elementary health education by anti-tuberculosis teams organised with international assistance.

Details of the assistance provided for the different regions during 1955, as compared with past years, are given below, in Tables I and II.

As in previous years, the expanded programme calls upon the resources of the world in recruiting experts and placing fellows. In 1955, experts came from sixty-nine countries and territories, and fellows studied in ninety-four. Special attention has been paid to co-ordination with other technical assistance programmes.

TABLE I—*Distribution of Direct Project Costs by Region*

Year	1953		1954		1955	
Region	Millions of U.S. dollars	Per cent	Millions of U.S. dollars	Per cent	Millions of U.S. dollars	Per cent
Africa	1,497	8·4	1,279	8·5	1,809	8·5
Asia and the Far East	5,719	32·1	4,650	30·8	6,622	31·1
Europe	1,568	8·8	1,500	9·9	1,706	8·0
Latin America	4,793	26·9	3,921	25·9	5,631	26·4
Middle East	3,528	19·8	3,252	21·5	4,676	21·9
Inter-Regional	713	4·0	509	3·4	866	4·1
Totals	17,818	100·0	15,111	100·0	21,310	100·0

TABLE II—*Cost of Various Kinds of Assistance*

Year	1953			1954			1955		
Type of assistance	Number	Millions of U.S. dollars	Per cent	Number	Millions of U.S. dollars	Per cent	Number	Millions of U.S. dollars	Per cent
Experts	1,825	13,585	76·2	1,652	11,194	74·1	2,108	14,250	66·9
Fellowships	1,195	2,532	14·2	1,542	2,540	16·8	2,431	4,670	21·9
Equipment and supplies	—	1,701	9·6	—	1,377	9·1	—	2,390	11·2
Totals	—	17,818	100·0	—	15,111	100·0	—	21,310	100·0

Planning and Management of the Programme

The report notes a considerable improvement in the general financial stability of the expanded programme, although the tempo of operations had to be held in check for a while during the first half of 1955. This improvement enabled the administrators of the programme, for the first time since the early days of its existence, to carry out all save a small proportion of the planned operations.

While the participating organisations continued to exercise day-to-day responsibility for their respective segments of the programme, T.A.B. and its secretariat, at headquarters and in the field, were again responsible for overall co-ordination.

Approximately two-thirds of the expenditure on projects was used to send experts to requesting countries, while more than half of the remaining funds was devoted to the award of fellowships. The field of activity upon which the largest sum was spent, 6·3 per cent of the total, was land and water use, with farm machinery and tools. An almost equal amount (6·1 per cent of the total) was devoted to manufacturing, processing and mining, while the third largest expenditure in terms of activity was the 5·8 per cent allocated to vocational training. Other leading fields of activity were animal production and disease control (4·7 per cent), crop production and protection (4·6 per cent), public administration (4·2 per cent), civil aviation (4·1 per cent), forestry (3·8 per cent), fisheries (3·1 per cent), and malaria and insect control (3·1 per cent).

The improvement in the financial situation in 1955 enabled the participating organisations somewhat to increase their provision of equipment needed in connection with their field activities, the T.A.B. report continues. The total value of equipment supplied during 1955 amounted to 2,390,000 dollars, as compared with a previous record figure of 1,701,000 dollars in 1953. It is felt that the provision of a considerable quantity of training equipment is a vital part of such technical assistance activities as the setting-up of a laboratory or a demonstration centre and it is increasingly realised that enduring economic progress can hardly be achieved without an investment in equipment to strengthen such basic institutions.

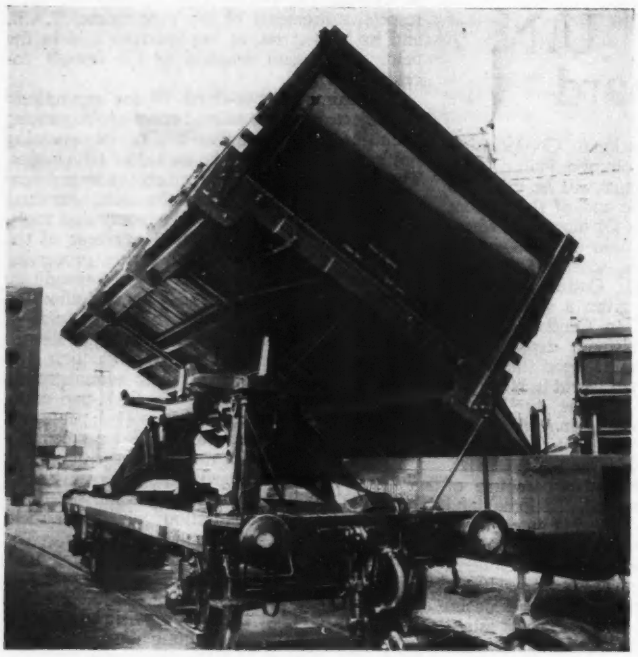
* The organisations participating in the expanded programme are the United Nations (U.N.), the International Labour Organisation (I.L.O.), the Food and Agriculture Organisation (F.A.O.), the United Nations Educational, Scientific and Cultural Organisation (U.N.E.S.C.O.), the International Civil Aviation Organisation (I.C.A.O.), the World Health Organisation (W.H.O.), the International Telecommunication Union (I.T.U.) and the World Meteorological Organisation (W.M.O.).

Plastic Pipework

The large-scale use of plastic materials for tubes is of fairly recent date, but already the advantages of plastic plumbing and its economy in general building work appear to have given rise to a constantly increasing demand. Many tube manufacturers have, in consequence, taken up the production of plastic tubing. An example is the formation of the Rhein-Plastic-Rohr G.m.b.H., Mülheim-Ruhr, by the German firms of Phœnix-Rheinrohr A.G., Wasag Chemie A.G., and Rheinische Gummi-und-Celluloid-Fabrik. The production programme of the new company includes tubes from soft and hard grades of "Nicolen" (high-pressure polyethylene and polyethylene Z respectively). These are manufactured in a proposed range of standard sizes up to 125mm outer diameter and for pressures up to 10 atmospheres. The second main material from which tubes are made is "Nicodur," a hard grade of polyvinyl chloride. Such tubes are made to German D.I.N. specifications up to 160mm outer diameter and 10 atmospheres working pressure, and in non-standard sizes to 310mm outer diameter. In addition the company produces "Nicodur" rods, and fittings made from "Nicolen". and "Nicodur."

The great corrosion resistance of plastic tubing is of obvious value in the chemical industry, where it was first applied. Among the advantages claimed for plastic domestic plumbing are, bends, corrosion resistance, savings in weight, and flexibility. Plastic pipes have a lower specific weight than metallic tubing, moreover, owing to the smoothness of the tube walls (which are stated to keep permanently free from deposits), a smaller bore size may be used. Flexibility, particularly when the tubes are slightly warmed, renders it easy to lay the pipes, which are not attacked by the chemicals with which they come into contact in walls or in the soil. Plastic pipework is resistant to frost, but ice inside the pipes cannot be thawed out with a blow-lamp because the pipes become plastic at higher temperatures. For the same reason plastic tubing is not suitable for hot water systems.

Fittings are available in metal or plastic and are connected by means of screw joints or, like the tubes themselves, by glueing. Welding, e.g. by high-frequency currents, is also practicable.



Lifting and tipping goods wagon in unloading position. Operation is electric-hydraulic by means of a supply cable

Two-Way Lifting and Tipping Goods Wagon

For some time past the Deutsche Bundesbahn has been considering new methods of speeding up the loading and unloading of bulk freight traffic. In connection with this work the railway company has worked in close collaboration with the Siegener Eisenbedarf A.G. (S.E.A.G.), of Greis-Tiefenbach (Siegen/Westphalia), in the design and production of a new two-way lifting and tipping goods wagon, shown in the accompanying illustration.

With this design it is possible to unload bulk freight whether directly into a bunker or road transport vehicles or on to the ground. The saving of time compared with manual handling is of the order of 90 per cent, which permits the road and rail transport vehicles to be used more economically.

The power to operate the lifting and tipping mechanism is provided by a small three-phase motor working at a voltage from 230V to 380V, the supply cable of which can be plugged into a nearby supply point.

The body of the wagon can be raised to a height of 1·6m (about 5ft 3in) before tipping, and it can be stopped at any height on its way up and tipped. The triangular lifting members and the associated tipping members are clearly shown in our illustration. Each side of the wagon is divided into three equal panels, the lower part of the panel being formed as a hydraulically operated flap. The centre panel has an upper portion which is composed of two doors, which can be opened together so as to give a full opening from the top to the bottom of the wagon side at the centre. All three of the lower flaps and the top double doors can be opened separately or together, and by this means a steady flow of material can be obtained and the discharge from the wagon controlled as desired. The controls for the lifting, tipping and door opening operations are arranged at the ends of the wagon body on either side.

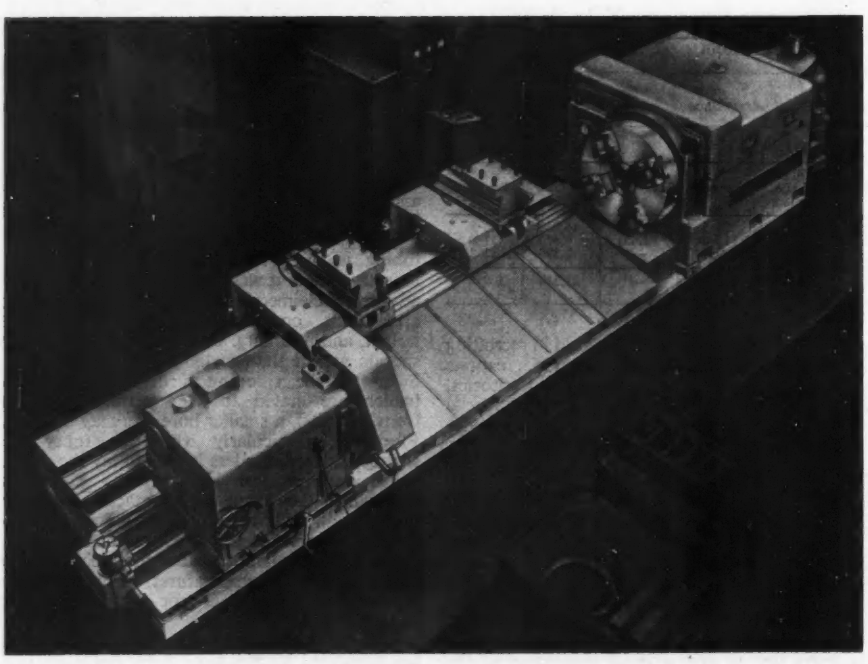
Heavy-Duty Roughing Roll Lathe

Our illustration shows a heavy roughing roll lathe for rolls of up to 52in diameter, built by Maschinenfabrik Herkules, Siegen-Marienborn, German Federal Republic. The machine has a very wide bedplate which slopes to the rear in order to permit the chips to flow away easily; openings for chip collection have been avoided so as not to weaken the bed. On the side of the tool carriages the bed is of heavy section, giving maximum rigidity there. The broad and well-supported tailstock is power-traversed and can be firmly locked by taper clamping devices to counteract any tendency to lift during turning. The tail spindle is rotating and has interchangeable centres and a pressure indicator for protecting the bearings.

The saddles have independent, infinitely variable feeds, derived from separate motors. The saddle guides are fitted with synthetic resin bearing strips and slide in inlaid hardened steel bedways.

In the headstock, roller bearings and helical gears are used throughout. The faceplate runs in a large diameter roller bearing, so that the main full gear is supported both by the main spindle bearing and the faceplate support bearing.

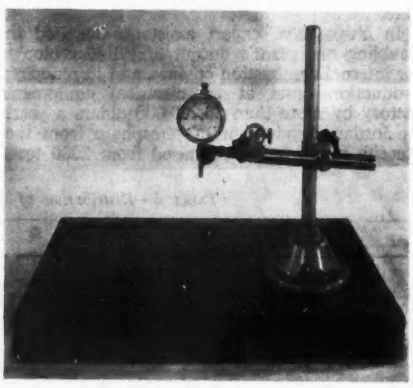
The maker claims that it is possible to achieve chip removal rates of up to 1½ tons per hour, using carbide cutting tools at 160–330ft per minute. The power consumption is 60–90 h.p. per tool. The agent in the United Kingdom is British and Continental Traders, Ltd., 329, High Holborn, London, W.C.1.



Heavy-duty lathe for roughing rolls up to 52in diameter

Suction-Clamped Test Indicator Stand

The base of the test indicator stand of which we show an illustration, is equipped with a suction device which enables the stand to be clamped to non-magnetic surface plates such as those made from granite. The stand, called the "Model PN," was developed by Hommelwerke, (17a) Mannheim-Käfertal, German Federal Republic, as an ancillary item for use with the firm's granite surface plates. It can, however, also be used to advantage with cast iron surface plates, and so avoid the danger of magnetisation which is particularly serious in high-precision work. The maker's U.K. agent, both for the "Model PN" stand and granite surface plates, is Rubert and Co., Ltd., Chapel Street, Levenshulme, Manchester.



Test indicator stand for granite surface plates, operated by suction clamp

Swedish Laboratory for Packaging Research

A package testing laboratory has recently been inaugurated in Stockholm. The institute is run by the Swedish Package-testing Association and is to carry out scientific research and also to solve practical problems, with particular consideration being paid to Swedish conditions. It was set up on the initiative of the Transport Research Committee of the Academy of Engineering Sciences, the State Railways, the Post Office and a number of paper mills and manufacturers of corrugated board. Close collaboration with similar research institutes abroad is to be maintained. The economic importance of this work becomes clear when one realises that expenditure on packaging in Sweden is at the rate of Kr.1000 million per annum.

The American Scene

BY OUR AMERICAN EDITOR

AUTOMOTIVE DEVELOPMENTS

SEVENTEEN miles north of Detroit, in what used to be a cow pasture, stands the large new Technical Centre of the General Motors Corporation, which was dedicated formally last month. These glass-and-brick buildings on a 330-acre site are now becoming the home of the engineers and designers who dream up the new engines and transmissions, the flashy styling and eye-catching accessories of future motor-cars. The complete centre will cost an estimated 100 million dollars. Practical, profit-conscious General Motors undoubtedly considers the money well spent. For creative engineering design to-day is considered to rank second only to styling in persuading the American public to buy a car. Automobiles have been getting lower, racier, more glistening and glittering than ever before. But even the sheltered housewife to-day wants something more than looks. When it comes to shopping for a motor-car, her vocabulary suddenly grows rich in such terms as torque transmission, rear axle ratios and the like. A recent survey by Packard showed that six out of ten buyers wanted special equipment on their vehicles, compared with only 4 per cent a few years ago. Ford recognised this trend in a recent advertisement which played down the car itself and advised readers to cast an eye on its " Magic Aire " heater, oil bath cleaner and full-flow oil filter.

Very few of to-day's mechanical " miracles " are really new. A patent for an automatic transmission was applied for even before the car was considered more practical than the horse. The V-8 engine, which is virtually unchallenged in the United States to-day, powered the Oldsmobile " Viking " of the late 'twenties, and even so antique a vehicle as the 1914 Cadillac carried one under its hood. The torque converter, which seemingly burst upon the American motorist in the late 'forties, actually was invented by Hermann Foettinger in the early part of the present century, and was on the Leland omnibus in 1933. What is new, however, is the American industry's general acceptance of the need, year after year, to come up with something supposedly better under the bonnet. The cars now in the showrooms, for instance, collectively boast an all-new engine, a new braking system, two revised automatic transmissions, a new power steering gear, heater, and a " six-way " power-operated seat. And the 1957 models, it is said, will unveil still more motoring innovations. The high-compression V-8 engine is driving ahead at full speed. Last year nearly twice as many were turned out as in 1954, and their number nearly equalled the combined volume of the three previous years. Still more are coming this year. The Plymouth division of the Chrysler Corporation recently opened a new, highly " automated " V-8 engine works, which can turn out 150 per hour. Similarly, the American Motors Corporation not long ago went into volume production of its own V-8. As a further indication of which way the traffic is moving, the latter engine was designed to provide for future displacement requirements and compression ratio increases. Now rated at 190 b.h.p., it can be boosted eventually to 300 b.h.p.

Along with the V-8 engine has come the automatic transmission, which has rendered the conventional hand-operated gearbox almost obsolete in the United States. Chrysler launched this trend in 1938 by putting a fluid coupling ahead of a lay shaft transmission, the cushion of oil allowing the gears to be shifted while the car was in motion. This was the famous " kick in the pants " transmission, in which the car shifted automatically, but with a considerable jolt. A year later, General Motors came out with volume production of the first fully automatic transmission. In 1956, with all the snags eliminated, such transmissions have become virtually standard. Of the 1956 Pontiacs, for example, no fewer than 93 per cent are equipped with " Hydramatic " transmission, as compared to only 70 per cent in 1948, when the device first was offered by this division of General Motors. In the more expensive Buicks and Oldsmobiles, the percentage is even higher. In the forthcoming 1957 models, automatic transmissions probably will be standard equipment on all the medium-priced cars, and within a few years even the less expensive cars will carry them as a matter of course. The year 1960 has been tentatively established as the date when the manually shifted transmission no longer will be available on American passenger cars. At present Detroit is endeavouring to make transmissions less complicated and expensive, as well as more efficient. Chrysler in its 1957 models is expected to position its automatic device underneath the front seat. In this way it will minimise the hump in the floor caused by the forward position of the transmission. This hump has been a styling headache, particularly with each succeeding model becoming lower than its predecessor. Since last year the Chrysler transmissions have been shifted by push buttons, and here a definite trend appears to be developing. Ford, which developed the modern buttons on its " X-100 " special car of 1952, is expected to employ them on all its 1957 models. Chevrolet is believed to be toying with them and Packard already has them. The Chrysler and Packard buttons, however, differ about as radically as buttons can. Chrysler's are situated to the left of the driver, to keep them away from children ; Packard's to the right. Nor does the difference end here. The Chrysler button is mechanical, the Packard product electrical. This difference is due largely to the fact that the Packard transmission is harder to operate by hand. The Chrysler system, in contrast, which consists of a single armoured cable running from the button box to the transmission, can be pushed with less force than would be exerted on a car radio. Its advantage, of course, is that it can be shifted on a dead battery. Even with a push the Packard cannot be started in gear. How far can push buttons go ? Actually, they can be used on virtually anything which operates fully on or off. Cadillac has a push button boot, and Chrysler's trafficator system on its 1957 models will operate on buttons. Yet the buttons are limited in scope. Packard, for example, came out with a push button dashboard in 1948. Unfortunately, a motorist one night pushed what he thought was a cigarette lighter only to turn off his headlights. Since the car at the time was rounding a bend, Packard found itself with a nasty suit on its hands. This experience is still fresh in the mind of the motor industry.

Aside from buttons, other products are being developed in conjunction with the transmission and the engine. The current styling trends are making the adoption of fuel injection increasingly likely within the next few years. Forthcoming car designs call for lowering bonnets still further, and this cannot be done with a big, bulky carburettor sitting atop the engine. Nobody in Detroit, in fact, would be very much surprised if one or two of the high-priced 1957 models introduced the fuel injection system. Nevertheless, in Detroit these days, the unexpressed feeling is that the era of the reciprocating engine is drawing to a close. This feeling was reinforced a few months ago when a Plymouth motor-car powered by a gas turbine successfully crossed the United States. Previously, General Motors had had a turbine in its " Firebird " developmental car, but the vehicle looked more like a guided missile than a car ; the Plymouth, on the other hand, was a stock model. But, American engineers believe, it will be at least five years before the gas turbine-driven car becomes generally accepted. The metallurgical and technical problems to be overcome are legion. Then, too, the cost of the turbine must be brought down to the point where it can be put in a production model and sold at a price which is not prohibitive.

So much for the long-term developments. As for the immediate future, a few points stand out. In terms of styling, the industry plans to lower the new cars still further by putting most 1957 models on 14in wheels, rather than the present 15in size. Detroit will continue to promote the " wrap around " windscreen. The next step in this direction, wrapping the windscreen up on the roof, is a possibility on some new models, but probably will not appear until the 1958 model year. These styling advances, of course, will be matched by " improvements " underneath the bonnet. Horsepower on the 1957 cars will be higher than ever, and the automatic transmission will take another big step toward becoming standard equipment on even the low-priced cars. New suspensions, including torsion bar designs, will be a major selling point. So, too, will the gadgets, such as the air conditioning systems, the high-fidelity gramophones, the electric shavers and the automatic sand spreaders. For the American motorist, having tasted the delights of power, has shown unmistakable signs of wanting still more of it.

Construction of Research Reactor at M.I.T.

THE U.S. Atomic Energy Commission has announced the granting of a permit to the Massachusetts Institute of Technology for the construction of a research reactor. The heavy-water-cooled-and-moderated reactor, enclosed in a gastight, steel-shell building, will be situated on the M.I.T. " campus " at Cambridge, Massachusetts, for use in medical therapy and in research and development work. The reactor will operate at power levels up to 1000kW using enriched uranium as fuel. A.C.F. Industries, of New York City, will construct the reactor for M.I.T. Upon satisfactory completion of construction, the permit will be converted to a forty-year A.E.C. licence to operate the reactor. Simultaneously with the issue of the construction permit, the Commission has allocated 9·7 kg of contained uranium-235 for use as reactor fuel over the period of the licence. This is a net figure—constituting transfers of U-235

from the Commission to M.I.T., minus returns to the Commission of U-235 in spent fuel elements.

The proposed reactor is based on the " CP-5 " (Chicago Pile 5) heavy-water-moderated-and-cooled reactor which has been in operation at the Argonne National Laboratory, Lemont, Illinois, since 1953. The M.I.T. design incorporated several improved automatic safety mechanisms to reduce operational hazards. The gastight steel shell, which is 70ft in diameter and 50ft high, will be anchored to a 3ft 6in thick concrete pad. It is designed to contain any fission products which may be accidentally released from the reactor. With the issue of the M.I.T. construction permit, for which application was made in February, 1956, seven permits or licences have now been issued by the Commission for the construction or operation of research reactors. The other reactors are intended for installation at the Armour Research Foundation, the Batelle Memorial Institute, the Naval Research Laboratory, the North Carolina State College, the Pennsylvania State University, and the University of Michigan.

6000MeV Synchrotron Particle Accelerator at Cambridge

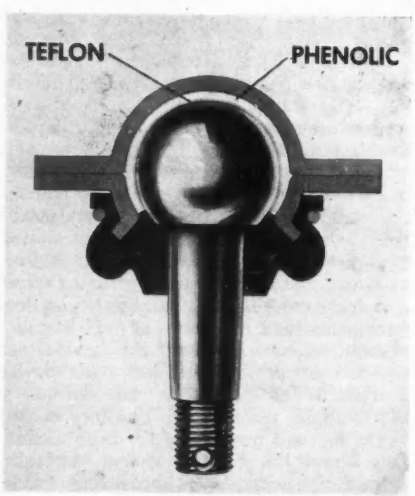
THE Massachusetts Institute of Technology and Harvard University will jointly design, build and operate at Cambridge, Massachusetts, a 6000MeV synchrotron to be called the Cambridge Electron Accelerator. It will be devoted to basic research in the structure of matter, and the work of the accelerator will be of general and fundamental scientific interest. The unit will be built at a cost of about 6,500,000 dollars with funds provided by the U.S. Atomic Energy Commission. Following the formal approval of an agreement between the Executive Committee of the Corporation of M.I.T. and the Corporation of Harvard University, the two institutions have ormed a joint management committee to operate the project. Work on the detailed plans will begin immediately and the machine will be completed in about four years. Dr. M. Stanley Livingston, Professor of Physics at M.I.T., will be its first director.

Design studies for a large electron accelerator have been conducted by a group from the Physics Departments at Harvard and M.I.T. for the past two years, supported in part by a joint programme of the Office of Naval Research and the Atomic Energy Commission. On the basis of these studies, the present plans for the Cambridge Electrón Accelerator call for a machine which will accelerate electrons around a circular underground trench building with adjacent laboratories for experimental work. The tentatively selected site is on Harvard property adjacent to its Cyclotron. Electrons entering the circular path at low energy will be accelerated as they travel around it by 16 r.f. circuits. Forty-eight laminated magnets, each measuring 2ft by 2ft by 11ft, will guide the electrons around the orbit. These magnets will provide the strong focusing forces required to hold the particles in their path. The electrons will emerge at very nearly the velocity of light ; indeed, they will be the fastest particles ever accelerated by man. The increase in the electron energy in the machine will be accompanied by a very large increase of mass : the emerging accelerated electrons will have a mass about 12,000 times that of the entering electrons. These high-energy electrons will emerge in pulses or bursts, at the rate of about thirty bursts per second. Travelling in this concentrated beam, the electrons will be directed at a small target in a shielded enclosure.

The electrons with 6000MeV of energy will be used as missiles to produce nuclear disintegrations or to generate high-energy X-rays used in turn to break apart nuclei. The high-energy electrons are expected to produce heavy mesons, negative protons, and other new unstable particles with energies higher than those that can be obtained in any machines now in use. The final design of the new machine will be carried out by a staff of about thirty scientists and engineers, including many members of the faculty and advanced students at both M.I.T. and Harvard. When completed the machine will be available to all faculty members and research students at both institutions who wish to make use of its high-energy particles. In addition, its facilities will be open to qualified research workers from other New England educational institutions.

Fabrication of Frictional Parts from " Teflon " Fibre

AN interesting development in the field of synthetic fibres, that may eliminate the need for conventional lubrication in many friction bearings, was recently announced by E. I. du Pont de Nemours and Co., of Wilmington, Delaware. This development is based on the use of " Teflon " tetrafluoroethylene fibre woven into fabric. The fibre, which is one of the most slippery materials known, can now be used under heavy load and has led to the development of improved bearings not requiring lubrication. Tests have shown that the use of fabric of " Teflon " fibre to face metal suspension



Cross sectional view of automotive suspension ball joint

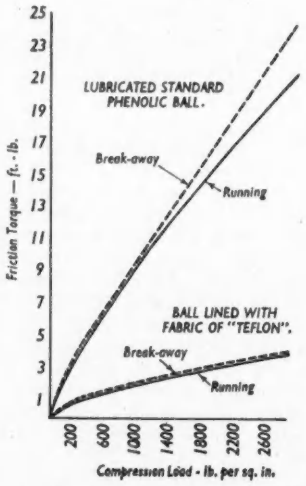
joints, in addition to functioning without customary lubrication, reduces the amount of friction by more than 50 per cent in comparison with standard lubricated automobile suspension joints.

This latest application for " Teflon " fibre was developed by the American Metal Products Company, of Detroit, Michigan, a manufacturer of automobile and aircraft parts, materials handling equipment, and plumbing fixtures. Most of the firm's efforts to date have been directed toward improved front and rear suspension components for automobiles, and several American motor-car manufacturers currently have such assemblies on test. As shown in the accompanying illustration, the use of " Teflon ' tetrafluoroethylene fibre in a ball-and-socket suspension joint is achieved by double weaving it with a backing of nylon or cotton. This fabric is then laminated with cotton-reinforced phenolic resin and formed into a cup which lines the socket. The mating metal parts are coated with a special grease to prevent corrosion. The joint is assembled and the preformed bearing is moulded in place, ensuring a perfect spherical contact between the ball stud and the bearing. The joint is then sealed. Preliminary testing indicates that these bearings will last the lifetime of the automobile without lubrication or other maintenance.

Many other frictional applications of the fibre, which may eliminate the need for conventional lubrication, are under development at the present time. They include spherical parts, such as rod ends and ball socket joints for special controls and self-aligning bearings ; cylindrical parts such as seals, bushings, pistons, and sleeve bearings for use in machinery ; and flat or sliding parts, such as leaf-spring end pads and slider beds for adjustable car seats and conveyor belts. The present development is believed to represent a new tool for the design engineer to use in solving mechanical problems, such as the lubrication of hard-to-reach parts, and the operation of frictional parts in extreme temperatures and in corrosive chemical environments. One promising use appears to be in bearings and other frictional parts on food and textile processing machinery, where the contamination of the product from lubricants is a problem. The new principle is expected to be used primarily in bearings and joints subject to intermittent motion. Conventional lubrication appears to enjoy advantages in bearings subject to continuous motion in one direction, at high speed and under high loads.

The advantages of using " Teflon " tetrafluoroethylene fibre in these and many other frictional parts include the elimination or reduction of preventive maintenance, machine downtime, and replacement parts. These should result in a lifetime of consistent performance with considerable savings in time, labour and materials and, in many applications, a marked reduction in the amount of power required. Tests conducted by the American Metal Products Company have shown that the suspension joint lined with a fabric of " Teflon " fibre reduces both the starting friction and the running load by more than half when compared with a standard lubricated joint. This comparison is illustrated by the graph reproduced herewith. For example, tests conducted under a compression load of approximately 1000 lb per square inch showed that a force of 9·4 lb was required to move the standard joint and a force of 7·0 lb to keep it moving after starting friction was overcome. The same test on a joint lined with fabric of " Teflon " showed the force required to be 2·1 lb initially, subsequently dropping to 1·2 lb. The smaller drop from the starting to the running friction results in less jolt, which means smoother operation.

Despite the important potential for the fibre in bearings, it certainly cannot be expected to replace all other materials. Each material has its own characteristics and operational range. For example, bearings of " Teflon " tetrafluoroethylene resin rather than fibre will do many jobs better and cheaper. This resin was introduced in the United States in 1943. Its fibre counterpart became available in experimental quantities in 1953 and is now available commercially as staple fibre, tow and continuous filament. The fibre is so nearly



Frictional performance of ball-socket joints under compression

indestructible that it is known as " dragon fur " by its developers. For instance, it will withstand temperatures up to 500 deg. Fah. and boiling in *aqua regia* without noticeable effect. Among the present uses for the fibre other than frictional parts, are fabrics, cords and braided structures for pump and valve packings, the filtration of corrosive liquids and gases, electrical and thermal insulation, and chemical processing diaphragms and gaskets.

Control of Cracks in Reinforced Concrete

DETAILED information on the cracking of loaded concrete beams and slabs has now been made available to the American construction industry as a result of recent investigations at the National Bureau of Standards, Washington, D.C. The data obtained promise to prove useful in controlling the spacing and width of cracks in the future design of reinforced concrete structures. In general, the results show that the width of cracks can best be controlled by using a large number of small reinforcing bars and by increasing the ratio of reinforcement. The investigation was carried out in the N.B.S. structural engineering laboratories by A. P. Clark, of the American Iron and Steel Institute Research Fellowship at the Bureau.

The formation of tensile cracks in reinforced concrete flexural members containing conventional, non-prestressed reinforcement is usually unavoidable since concrete has a low extensibility. While cracks barely wide enough to be visible may be objectionable only because of appearance, cracks of appreciable width can be a source of danger because of the possibility of corrosive agents attacking the steel reinforcing bars. An excessive width of cracks can also permit undesirable leakage in such hydraulic structures as dams, tanks, or pools. It has been found that by increasing the bond strength between the concrete and the steel with improved reinforcing bars, the widths of the cracks may be reduced. During the past ten years, the American reinforcing bar industry has developed such improved "deformed" reinforcing bars. The results of a previous investigation with axially loaded cylindrical specimens showed that the improved bars reduce the crack width 20 to 40 per cent compared to older bar designs. However, until the recent investigation at the N.B.S., there had been no systematic tests with beam and slab specimens using the new and improved bars. The investigation was undertaken to provide data on beam specimens containing the new designs of reinforcing bars.

The study of crack formation included tests on fifty-eight beam and slab specimens. The beams were of two sizes: 6in by 15in by 11ft, tested on a 9ft span, and 6in by 23in by 13ft, tested on an 11ft span. The slabs measured 6in deep, were from 6in to 15in wide and 8ft long, and were tested on a 6ft span. All specimens were tested as simply-supported beams with the loads being applied at the quarter points. The specimens were cast in steel moulds, and all were obtained from the same concrete mixture. The tensile reinforcement, constituting deformed bars of a commercially available design, was placed near the bottom of the mould. Three standard 6in by 12in cylinders were cast with each specimen to determine the compressive strength of the concrete. These cylinders were cured and stored in the same manner as the specimens, and were tested at the same age.

The widths of the cracks were measured with 6in Tuckerman optical strain gauges equipped with ½in lozenges (Fig. 1). In order to include every crack that might form within the region of constant bending moment, two rows of these gauges were placed at equal distances from the longitudinal centre line of the specimens. The gauges in the two rows were staggered and overlapped ½in. The strains in the tensile reinforcement were determined with electric strain gauges, and the deflection at the centre of the span was measured with taut-wire scale devices, with the wires being stretched between two points directly over the supports. The tests were performed in a 600,000 lb capacity hydraulic machine (Fig. 2). To facilitate placing and reading the Tuckerman gauges, the specimens were tested in an inverted position. The load was applied in increments which ranged from 500 lb to 5000 lb, and the loading proceeded until the specimen failed by the yielding of the reinforcement. The position and the extent of the cracks were recorded immediately following the application of each increment of load.

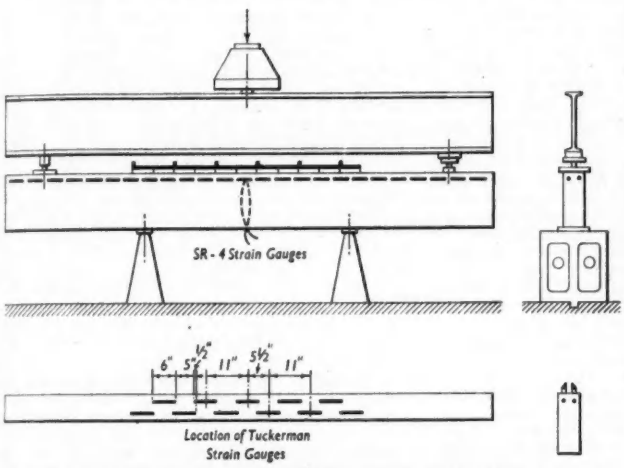


Fig. 1—Reinforced concrete beam testing apparatus with Baldwin "SR-4" resistance strain gauges and Tuckerman optical strain gauges

For the individual beam specimens the ratio of maximum width of crack to the average width ranged from 1·18 to 2·77. However, the average maximum width of crack was about 1·64 times the average width for each value of stress considered, where the computed steel stresses ranged from 15,000 lb to 40,000 lb per square inch. Where the computed stress in the steel was 20,000 lb per square inch the crack width ranged from 0·001in to 0·005in; for a stress of 30,000 lb per square inch the values ranged from 0·002in to 0·007in; and at 40,000 lb per square inch, ranged from 0·004in to 0·010in. The average spacing of the cracks decreased rapidly with an increase in steel stress beyond that causing the first crack, and at a stress of 30,000 lb per square inch or more the average spacing appeared to approach a constant value. For the individual specimens, the minimum average crack spacing varied from approximately 3in to nearly 7in, with a 4in average spacing being obtained for all of the specimens.

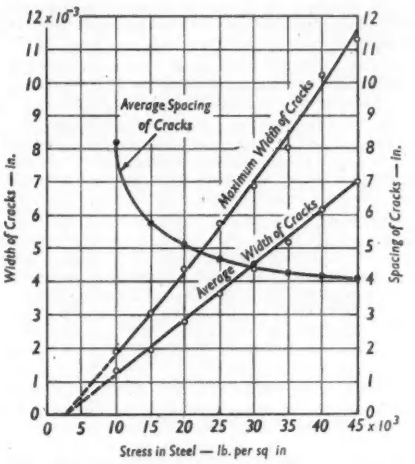

12 x 10⁻³
Average Spacing of Cracks
Maximum Width of Cracks
Average Width of Cracks
Width of Cracks — In.
Spacing of Cracks — In.
0 5 10 15 20 25 30 35 40 45 x 10³
Stress in Steel — lb. per sq in

Fig. 3—Graph showing results obtained in the testing of reinforced concrete beams and slabs

Since concrete is a heterogeneous material and cracks occur at random, the position and spacing of the cracks are subject to considerable variation. While the results (Fig. 3) showed considerable scatter, it was found that an equation, which had been previously derived for symmetrically reinforced and axially loaded specimens, could be adapted for flexural members. The average width of cracks was found to be proportional to the increase in steel stress beyond that causing initial cracking. The average width was also found to be proportional to the product of two parameters D/p and $(h—d)/d$, where D is the diameter of the bar, p is the ratio of reinforcement, and h and d are, respectively, the overall and effective depths of the beams. These observations are in qualitative agreement with the findings of other investigators who reported that the width of cracks can be reduced by using a large number of small bars and by increasing the ratio of reinforcement.

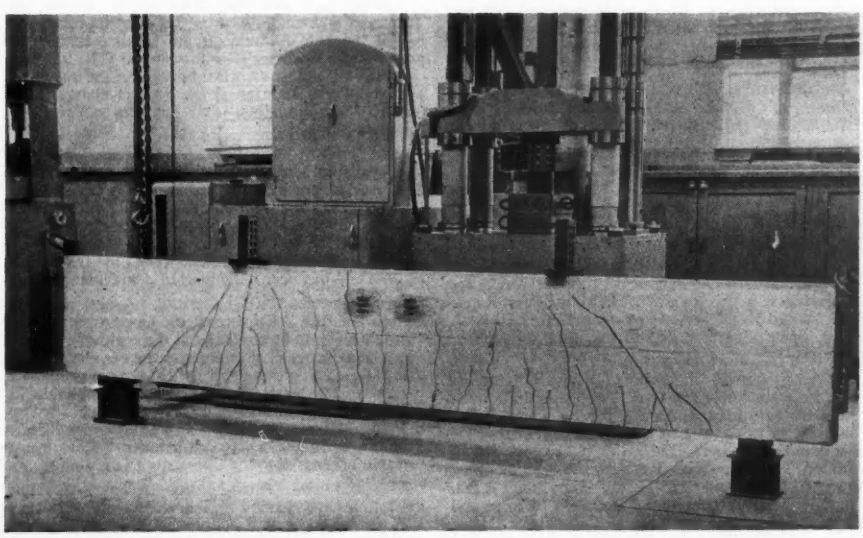


Fig. 2—Representative beam specimen after cracking test in a 600,000-lb hydraulic testing machine

Personal and Business

Appointments

DR. J. M. KAY has been appointed by the University of London to the newly-instituted Chair of Nuclear Power at the Imperial College.

THE BRITISH CENTRAL ELECTRICAL COMPANY, Ltd., states that Mr. A. Rose has joined them as manager of their plant department.

MR. A. DUNCAN MILLAR has been appointed a member of the North of Scotland Hydro-Electric Board for the period until December 31, 1958.

MR. W. T. COOPER, editor of the *Journal* and other publications of the Institute of Fuel, is resigning at the end of July. He will take an appointment as Senior Research Officer, Australian Commonwealth Scientific and Industrial Research Organisation.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., announces that Mr. A. N. E. McHaffie has retired from the board of the company. It is also stated that the following have been appointed to the board of the Hotpoint Electric Appliance Company, Ltd.:—Mr. H. F. Adams, as director of manufacture; Mr. D. H. Graham, as director of design; and Mr. D. T. L. Rettie, as director of marketing.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces that Mr. A. C. Ellis, who became district manager of the firm's Cardiff office in 1952, has returned to the company's Manchester office as district manager, on the retirement of Mr. J. B. Hartley, who will remain in an advisory capacity until the end of September. Mr. J. S. Hall, Assoc. I.E.E., has been appointed manager of the Cardiff office in succession to Mr. Ellis.

Business Announcements

THE BRITISH TRANSPORT COMMISSION states that Mr. F. B. Illston, carriage and wagon engineer, Southern Region, retired on June 30th.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces that the telephone number of the firm's Exeter branch has been changed to Exeter 66018–9.

J.L.S. ENGINEERING COMPANY, Ltd., has moved into new works and offices at Abbeydale Works, Brook Street, Redditch, Worcs (telephone, Redditch 3397).

CHARLES CARR, Ltd., states that a London office has been opened by the firm at 19, Great Winchester Street, London, E.C.3. (telephone, London Wall 6714–6715).

C. A. PARSONS AND CO., Ltd., states that Mr. F. W. Gardner, director and general manager, is retiring on June 30th, but is retaining his position on the board of directors.

THE MIDLAND AREA OFFICE of the Cape Asbestos Company, Ltd., has been moved to new premises at 11, Waterloo Street, Birmingham, 2 (telephone, Midland 6565–6–7).

ROBERT HUDSON, Ltd., announces that its London office address is now Locomotive House, 30–34, Buckingham Gate, Westminster, S.W.1 (telephone numbers, Abbey 7127–8–9).

ALAN MUNTZ AND CO., Ltd., announces that the firm of Alexander Stephen and Sons, Ltd., has taken a non-exclusive sub-licence for marine and industrial purposes for the Pescara free-piston gasifier.

THE INSTITUTE OF METALS with the *Journal of the Institute of Metals*, *Metallurgical Abstracts* and *Metallurgical Reviews* has moved to 17, Belgrave Square, London, S.W.1 (telephone, Belgravia 3291).

THE DUNLOP RUBBER COMPANY states that permission has been given for the erection of a £5,000,000 synthetic rubber plant at Fawley, Southampton, by the International Synthetic Rubber Company, Ltd.

W. WESTWOOD AND SONS, Ltd., states that as from July 2nd all correspondence and supplies which are at present sent to Apex Works, Manchester Road, E.14, should be addressed to Darenth Works, Marsh Road, Slade Green Road, Erith, Kent (telephone, Erith 4514).

BENTONE-VERKEN announces that arrangements have been made for the import and distribution in Great Britain of the firm's Swedish oil burner. The following firms have been appointed distributors:—Bentone Oil Burners, Ltd., 102, Chepstow Road, London, W.2 (telephone, Bayswater 5157); Bentone Burners (Scotland), Ltd., 588, Garscube Road, Glasgow, N.W. (telephone, Douglas 7606); and Bentone Heating Equipment Company, Brown Street, off Worsley Street, Salford, 3, Lancashire (telephone, Blackfriars 1474).

Contracts

THE ENGLISH ELECTRIC COMPANY, Ltd., has been awarded a contract for the supply and erection of five water turbines and their alternators, each set developing 77,000 h.p., for a new power station on the Rihand River, a tributary of the Sone, near Pipri Village, in the State of Uttar Pradesh, India. The value of the contract is £1,250,000. The station is to feed power into the Ganges Plain network to meet increasing demands for the supply of electricity for agriculture and industry.

THE AUTOMATIC TELEPHONE AND ELECTRIC COMPANY (N.Z.), Ltd., has received an order to supply single-channel v.h.f. radio links to register consumer demand and control load shedding between the headquarters of the South Canterbury Electric Power Board, New Zealand, and three of its substations. The Board's headquarters are at Timaru and power is taken from three points at Temuka, Grants Hill and Studholme, on New Zealand's 11kV grid. The radio, links will replace conventional open-wire lines between these substations and the Timaru control centre. Consumer demand will be metered at the substations, transmitted over the radio links and then summated at headquarters for the automatic control of load shedding. A supervisory and remote-control system will be used to supervise control equipment at the Grants Hill substation from Timaru. Initially the other two substations will be fitted with metering equipment only, but provision will be made to extend the supervisory system to them, if required, in the future.

STANDARD TELEPHONE ET RADIO S.A. ZURICH has received from the Swiss Posts and Telegraphs Department an order for s.h.f. radio equipment, to link Berne with Geneva, providing 600 telephone circuits over a single radio channel, with facilities for future extensions. The equipment will be designed and manufactured in England by Standard Telephones and Cables, Ltd., and will comprise terminals at Berne and Geneva with a repeater station at Chasseral. The equipment will comprise a system equipped initially with one working and one spare r.f. channel for 600 telephone circuits, i.e. ten "supergroups." Normal expansion will enable this to be extended to six r.f. channels in the band 3800-4200 Mc/s, and if necessary additional channels can be added in the band 3600-3800Mc/s. These additional r.f. channels can be used for further telephone circuits or for television links. The frequency division channelling equipment used will provide facilities for "through-group" and "through supergroup" working with other systems, e.g. a standard coaxial or radio system. At the terminal stations, the equipment for each radio frequency channel will consist of transmitter and receiver cubicles, the transmitter being equipped with a travelling-wave amplifier which will deliver an output of 5W to the aerial system. At the repeater station, two one-way 5W repeaters will be required, each consisting of one cubicle mounting the transmitter and receiver. The aerial systems will consist of beamed paraboloid elements.

Miscellanea

SIGNALLING LAMP BATTERIES.—The Ministry of Transport and Civil Aviation has now approved the use of the Nife nickel-cadmium alkaline battery to power the 60W Mark X Aldis lamp. The alkaline cells, for an almost identical burden on the signaller, give about ten times longer life between charges than lead-acid accumulators, and are less affected by rough handling.

INSTITUTION OF MINING ENGINEERS.—We are informed that Mr. E. H. Browne, C.B.E., M.A., has been elected president of the Institution of Mining Engineers for the year 1957–58, and will succeed Dr. William Reid at the sixty-third annual general meeting of the Institution to be held in London on January 31, 1957. Mr. Browne joined the Institution in 1934 and has been a member of council since 1943.

OPPORTUNITIES FOR GRADUATES.—A new national edition of the "Directory of Opportunities for Graduates" is to be published at the beginning of next year. It will consist of announcements by various industrial and commercial firms of the type of graduates they wish to recruit and the openings available in their organisations. The directory will be published by the Cornmarket Press, Ltd., 1, Lower James Street, London, W.1, and will be distributed free to every last year student at every University in the country.

WELDING OF HIGH-NICKEL ALLOYS.—A film in colour produced by Henry Wiggin and Co., Ltd., was shown in London last week. The film demonstrates the joining of various wrought nickel alloys, and whilst it is mainly concerned with Monel, nickel and Inconel it includes references to Nimonic 75 sheet fabrication and to Corronel B, a corrosion-resistant alloy. Great stress is laid on the need for cleanliness of the work to be joined, and various methods of removing contamination and oxide scale are shown. Means for the control of distortion during welding are illustrated, together with some of the jigs employed.

"THE FERODO STORY."—A film in Eastman colour, produced by the J. Arthur Rank Organisation for Ferodo Ltd., was shown recently in London. The film portrays the development of brake and clutch linings, from the days of Herbert Frood, the founder of the firm, to the present day. Some of the many processes necessary in the production of the wide range of friction materials manufactured, are illustrated by scenes inside the company's factory at Chapel-en-le-Frith. Motor racing, together with the many checks and inspections carried out in the laboratory, plays an important part in the programme of testing. Engineering applications from many different industries are presented, including mining equipment, earth moving machinery and agricultural machines. This film is available in 16mm and 35mm sizes, with sound tracks in English or Spanish.

RAILCARS IN AUSTRALIA.—Stainless-steel narrow-gauge railcars powered by diesel engines supplied by British United Traction, Ltd., are being placed in service in Australia by Queensland Railways. These railcars are built by Commonwealth Engineering Company, Ltd., and they incorporate many points in American design, while the power units are similar to those now being used by British Railways. The Commonwealth Engineering Company, Ltd., has developed three types of standard railcar suitable for operation on all the 3ft 6in gauge railways in Australia, each type being designed for a specific purpose, such as suburban, inter-urban, branch line or excursion services. They are designed to operate in sets of ten cars which are coupled together and operated from the driver's cabin of the leading car. Two 125 h.p. B.U.T. diesel units coupled to a torque converter and a reversing gearbox are used to drive each car, as against the 150 h.p. B.U.T. units employed by British Railways.

B.B.C. NEW MOBILE STUDIO.—A new B.B.C. mobile studio and control room will be used for outside broadcasts from the Royal Show at Newcastle upon Tyne from July 3rd to 6th. The vehicle is 22ft long, 7ft 6in wide and 9ft high. It contains an acoustically treated studio 10ft long by 7ft wide and an operations room for controlling the output of the studio and a number of external sources, such as commentators' microphones. Provision is also made for recording and reproducing programmes, for the introduction of effects from gramophone discs and for the reception of speech from commentators using a radio microphone. Telephones give communication with permanent B.B.C. centres and other points, while the control engineer's and producer's positions are equipped with talk-back facilities enabling them to speak to the studio, or to the commentators for briefing. A radio receiver is installed to allow a programme to be fed for cueing to any desired point connected to the mobile studio and control room. The output from the mobile control room can be sent to the nearest permanent B.B.C. centre either over G.P.O. lines or over radio circuits, and duplicate transmitters have been installed in the vehicle. The whole equipment can be operated from the public electricity supply or from built-in batteries.

FINANCIAL HELP FOR TECHNICAL STUDENTS.—Mr. F. D. Edwards, founder and managing director of Edwards High Vacuum, Ltd., has formed the Frederick D. Edwards Scholarship Trust to give financial help to students. The trust takes a very practical form, as Mr. Edwards makes it clear in the trust deed that the trustees will have a very free hand in granting awards which are not confined to scholarships, bursaries and prizes. It is stipulated that the whole of the capital and income of the trust fund (amounting to £12,000) should be spent within ten years. Three institutions are specifically mentioned in the trust deed—the Northampton Polytechnic, the National College of Instrument Technology and the Crawley Technical College, but awards are not limited to students of these three centres; —those who wish to attend any other institution giving training courses or facilities for research in any branch of science or technology are equally eligible. Enquiries about the trust and applications for grants should be made through College principals to either of the two trustees: Mr. F. S. B. Murrells (director and secretary of Edwards High Vacuum, Ltd.), Tresco, Nevill Court, Tunbridge Wells, Kent; or Mr. A. J. Philpot (retiring director of the British Scientific Instrument Research Association), Cranley, Bressey Grove, E.18.

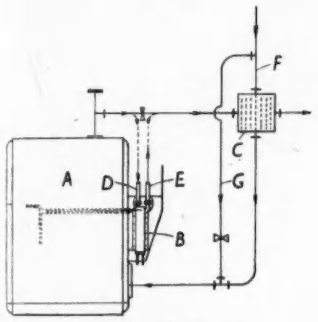
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. each.

STEAM GENERATORS

750,161. April 30, 1953.—BOILER EQUIPMENT, The Superheater Company, Ltd., and Robert Grey Clements Richardson, both of 53, Haymarket, London, S.W.1.

The invention relates to Scotch boilers and associated superheaters and is more particularly concerned with steam auxiliary equipment in diesel-driven vessels. It provides a Scotch boiler and integral superheater from which a steady low degree of superheat is obtainable at any boiler load, which permits steam having a constant temperature to be obtained for use in the auxiliary equipment. In the drawing *A* is a Scotch boiler, *B* a smoke tube superheater, and *C* a non-contact steam air heater, while *D* is the saturated steam line to the superheater, and *E* is the superheated steam line to the engine which line



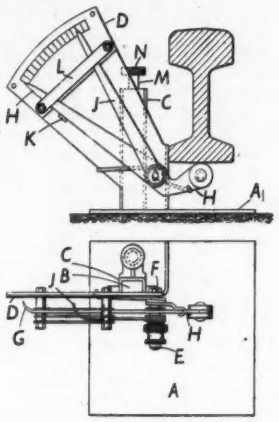
No. 750,161

passes through the steam air heater. *F* is the air line through the heater *C* to the burners and *G* is a damper controlled air by-pass for the heater *C*. In this installation the steam air heater consists of a number of gilled tubes attached to inlet and outlet headers. The steam air heater *C* does not suffer from the disadvantages of combustion gas air heaters, such as choking or corrosion, nor does it require any steam for soot blowing. Superheated steam is pure, and thereby the inside of the tubes will suffer no deterioration and the gilled surfaces on the outside will remain clean, as air from the engine-room is passed over these. The superheater *B* slightly reduces the funnel base temperature and thereby increases the total efficiency of the steam generating units. It is stated that 50 deg. Fah. of superheat in the steam, maintained constantly, will return approximately a saving in fuel of 5 per cent, and this can be maintained with the proposed arrangement at a constant figure of 425 deg. Fah., which meets requirements for ordinary materials in the valves and steam lines. Furthermore, this temperature is maintained over the whole of the range of boiler loads—or, in other words, the economy is obtained at all times when the steam auxiliaries are in use, both at sea and in port.—*June* 13, 1956.

RAILWAY ENGINEERING

750,204. February 24, 1954.—MEANS FOR MEASURING THE AMOUNT OF DEPRESSION OF RAILWAY SLEEPERS UNDER LOAD, Abtus, Ltd., Vandon Court, Petty France, London, S.W.1. (*Inventors: Ivy Tustain and Bernard Llewellyn Middleton.*)

The invention relates to meters for measuring the depression of railway sleepers into the ballast when rolling stock passes over the track and more specifically to improvements in meters as described in the Specification No. 681,075. As shown in the drawing, the improved meter includes a flat metal base *A* on which is mounted a vertical guide *B* for a bracket *C* to which is secured a plate *D* having a graduated scale. On this plate is a spindle *E* secured to the plate by a nut *F*. Pivotally mounted on a reduced portion of the spindle is the double-armed lever having a longer arm *G* constituting a pointer, and a shorter arm *H* adapted to be engaged beneath a rail. A coil spring holds the lever *H* up against the bottom of the rail and the end *G* of the pointer toward the left-hand end of the scale. Also mounted to pivot on the spindle *E* is a second pointer *J* frictionally clamped by a spring. The pressure on the pointer *J* and the washers by the spring produces friction in the movement of the pointer about the spindle. Movement of the pointer *J* is effected by means of a projection *K* on the arm *G* engaging the pointer. To prevent damage to the pointers they are guided in their movement by means of straps *L*. In order to ensure that the lever arm *H* will contact the bottom of the rail with the base *A* located on the track ballast, the measuring device, consisting of the double-armed lever and the pointer and the plate, can be raised in relation to the base. In use, the device is located on the track ballast with the lever arm depressed

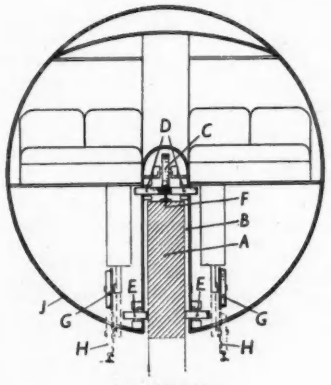


No. 750,204

beneath the rail. If the bottom of the rail is above the end *H* of the lever, the measuring unit is elevated by rotating the threaded spindle *M* by means of the knob *N* until the end *H* abuts the rail with the other end *G* of the lever at zero or thereabouts on the graduated scale. Upon movement of the pointed *H* due to deflection of the rail, the pointer *J* will be moved therewith up to the position determined by the deflection of the rail under load and retained there by friction while the pointer *H* returns to initial position under the influence of its spring. The distance between the pointers on the scale is an indication of the amount of the rail deflection and/or sleeper depression.—*June* 13, 1956.

750,138. October 2, 1952.—MONORAIL RAILWAY SYSTEM, Alweg-Forschung G.m.b.H., 25, Cacilienstrasse, Köln, Germany.

An object of the invention is to provide an improved vehicle for use in a monorail system for high-speed transport. A three-vehicle train has a streamline configuration and straddles a beam-shaped elevated supporting structure *A*. The drawing shows a cross section of one form of the vehicle, which, apart from the tunnel-like intersection *B*, is circular, resulting in a minimum of superficial friction. The supporting wheel *C*, guide wheels *D*, and stabilising wheels *E*, are assembled in a common undercarriage, the guide wheels and stabilising wheels being arranged in pairs in front of, or behind, the supporting wheels. The



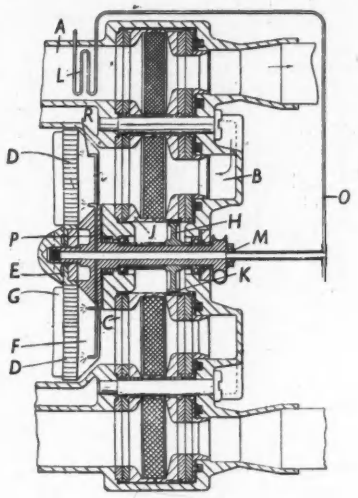
No. 750,138

lateral guide wheels *D* resiliently contact the sides of a running track *F* bearing the supporting wheel. The supporting wheels are arranged for direct drive. The driving wheels are driven by directly coupled motors. The vehicle body is supported through a suspension system by the bearings of the driving wheel axles. In order to facilitate the universal use of the railway—that is to say, not only on the monorail, but also on two-rail tracks or on the road, which is necessary under certain conditions for reaching railheads—pairs of auxiliary wheels *G* which can be extended are arranged in the lower part of the vehicle body. These pairs of wheels can be provided for any desired gauge. In the swung-out position, the pairs of auxiliary wheels are indicated at *H*. Moreover, it is possible to provide the shell *J* with an inner vehicle body and to arrange it so that the inner vehicle body, when travelling over curves, can always adjust itself automatically to the correct angular position under the action of centrifugal force. —*June* 13, 1956.

GAS TURBINES

749,904. June 23, 1952.—HEATING UNITS FOR COMBUSTION TURBINES, C. A. Parsons and Co., Ltd., Heaton Works, Newcastle upon Tyne, 6. (*Inventor: Waldemar Hryniszak.*)

The invention relates to heating units for combustion turbines; for heating the working medium usually air is heated, prior to expansion in a turbine.



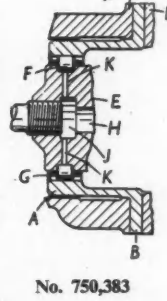
No. 749,904

Its object is to provide an improved heating unit in which a mixing process forms a gas mixture in the combustion chamber of uniform temperature. The heating unit comprises the combination of a regenerative heat exchanger of the rotary disc type, with a combustion chamber burning a vaporised fuel and having a rotary flame trap. The heat exchanger shown is that described in the co-pending Specification No. 735,177. Referring to the drawing hot gas from the turbine exhaust enters the respective disc rotors via the annulus *A* and cold air from the compressor via the inside annulus *B*. Near the outlet *C* of the combined cold gas sides is a rotary flame trap *D*. A rotor *E* is fitted with radial inlet vanes *F* and outlet vanes *G*, which divide the rotor up into a number of compartments, some of which contain the flame trap material of honeycomb cross section or perforated sheet or gauze. The rotor is mounted on the same shaft as gear wheel *H*, which drives respective rotors *J* of the regenerator by meshing with teeth *K* on the outer periphery of each rotor *J*. The rotor *E* can also be driven by impinging fuel/air mixture itself by suitably shaping the vanes *F* and *G*. The fuel is vaporised in a heating coil *L* in the hot gas inlet annulus *A* of the regenerator and is then led through pipe *O* and the hollow shaft *M* to distributing pipes *P*, which have nozzles fitted to their ends.—*June* 6, 1956.

BEARINGS AND SUPPORTS

750,383. May 10, 1954.—LUBRICATING ROLLER BEARINGS, The Rover Company, Ltd., Meteor Works, Lode Lane, Solihull, Warwickshire. (*Inventor: Charles Spencer King.*)

The invention relates to means for lubricating roller bearings, and its object is to avoid portions of the bearing being starved of lubricant by centrifugal force when the bearing is supporting a shaft, such as a shaft on which is mounted the rotor of a compressor, or a turbine, of a gas turbine power plant, which rotates at high speed. The drawing is a longitudinal section through a bearing in accordance with the invention and shows an outer roller race *A* provided at one end with a radial flange *B* by which it is clamped between stationary parts *C* and *D*. The high-speed shaft *E* is provided with a hardened, peripheral groove forming the inner race for the rollers *F*, which are supported in a cage *G*. The shaft has an axial bore *H*, to which liquid lubricant



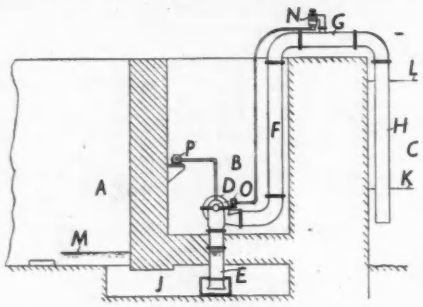
No. 750,383

is supplied, which communicates with one end of an internal chamber *J* of the shaft, the other end of the chamber being sealed by a screw of which only a part is shown and which is for securing a component, such as the rotor of a compressor of a gas turbine engine, to the shaft. A number of radial ducts *K* lead from the chamber *J* to the centre of the groove defining the inner race for the rollers, and it will be seen that the rollers in passing over the outer ends of these ducts will give rise to pulsations in the centrifugal feed of the lubricant to the bearing and will also squash it out in the axial and circumferential directions of the inner race. The lubricant thus spread will also be transferred by the rollers to the working surface of the outer race.—*June* 13, 1956.

DRY DOCKS

750,272. May 22, 1954.—PUMPING INSTALLATIONS FOR DRY DOCKS, Drysdale and Co., Ltd., and John Young, both of the company's address at Bon-Accord Works, Yoker, Glasgow.

The invention is intended to improve the lay-out of the pumps and piping. Referring to the drawing, *A* is a dry dock, *B* an additional pump-house chamber, and *C* the tidal water. *D* is a centrifugal pump within the chamber *B* and having a suction



No. 750,272

pipe *E* and a valveless siphon discharge pipe, including limbs *F*, *G* and *H*. The pipe *E* rises from a culvert *J*. *K* and *L* are the low and the high-water levels, respectively, on the tidal side, and *M* the starting water level in the dry dock with the pump and the siphon empty to sealing levels. On the top of the siphon an air release valve *N* is provided for the purpose of "breaking" the siphon. This valve is operated by oil pressure from a servo pump *O* driven from the main pump. The pump *O* provides an oil pressure which lifts a piston and shuts off the air from the siphon. Should the pump *D* stop for any reason, the servo oil pressure drops and the valve *N* opens by gravity with the assistance of a deadweight bias. Thus there is no danger of the siphon reversing and filling the dock should the pump motor fail. It is also possible to have an auxiliary by-pass to the servo pump *O*, so that the dock pump *D* may work without siphon assistance should it be desired to deliver a smaller quantity. The efficiency of pumping is improved by the absence of valves on the discharge siphon, and the pump-house chamber *B* is protected against any possible chance of pipe breakages on the discharge side, which, in a conventional arrangement, may flood out the chamber and destroy the electrical equipment. An air exhausting pump *P* connected to the suction side of the pump *D* is also provided.—*June* 13, 1956.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

METHODS OF TESTING VULCANISED RUBBER

No. 903. This Standard is to be published in separate parts. This arrangement will make the methods more easily available and will facilitate the issue of future revisions. The last revision appeared in 1950. The following parts are now available. Each includes a summary of the method, details of apparatus required, requirements for the preparation of the test piece, test procedure, and the method of calculation for the determination indicated by the title of each part. The year of issue is 1956 in each case.

Part A1, "Determination of Density and Specific Gravity, price 2s.; Part A2, "Determination of Tensile Stress-Strain Properties," price 3s.; Part A3, "Determination of Tear Strength, price 2s. 6d.; Part A10, "Determination of Resistance to Flex Cracking," price 4s.; Part A11, "Determination of Resistance to Crack Growth," price 2s. 6d.; Part A16, "Determination of Swelling in Liquids," price 4s.; Part A18, "Determination of Equilibrium Water Vapour Absorption" (applicable also to ebonite), price 2s.; Part A19, "Methods of Carrying Out Accelerated Ageing Tests"* price 3s.

An extension to B.S. 903 has also been issued. The parts (F1 to F9) cover the testing of soft cellular rubber (as opposed to soft vulcanised rubber and ebonite, which is covered in the earlier parts of B.S. 903). Available under one cover at 6s., Parts F1 to F9 include data on the preparation and conditioning of test pieces and on the measurement of their dimensions. Details are given of apparent density, compression stress-strain, swelling in liquids, compression set, tensile strength and elongation at break, ageing, and water extract.

DIMENSIONS OF CONDENSER RUBBING LEATHERS FOR COTTON WASTE AND WOOLLEN CARDING ENGINES

No. 2716 : 1956. Price 2s. This standard has been issued as part of the programme of standards for accessories, which is being developed by the Textile Machinery Industry Standards Committee. The aim which the Textile Machinery Industry Standards Committee held in view when preparing the standard was to establish by agreement among machine makers, condenser rubbing leather makers and users, standard dimensions for single rubber tape condensers and single stripper condensers used in the cotton waste and woollen trades. The standard provides a range of three widths of condenser rubbing leathers for carding engines 60in, 66in and 72in wide, for the production of cotton waste yarns and woollen yarns. Two lengths of condenser rubbing leathers are specified, for rubbing rollers with 12in and 14in nominal centres, respectively. The rubbing leathers are suitable for both single rubber tape condensers and single stripper condensers used in the cotton waste spinning and woollen spinning trades.

COPPER ALLOY CHECK VALVES FOR GENERAL PURPOSES

No. 1953 : 1956. Price 5s. This standard is the second in a series for copper alloy valves for general purposes. It is hoped that this series will be followed in due course by other series of standards for ferrous valves for general engineering use. The standard specifies requirements for rating, design and manufacture, materials, dimensions, tests and marking in respect of copper alloy check valves corresponding to the following details :

Type	... ...	Swing, piston, disc and ball
Ends	... ...	Flanged or screwed
Classes	... ...	100, 125, 150, 200 and 250
Size range	... ...	¼in to 3in.

COPPER ALLOY GATE VALVES FOR GENERAL PURPOSES

No. 1952 : 1956. Price 6s. This standard specifies requirements for : rating, design and manufacture, materials, dimensions, tests and marking in respect of the following copper alloy gate valves :

Types		Ends	Class/Size
Solid or split wedge and Double disc or parallel slide	With inside screw, rising or non-rising stem ; and with outside screw, rising stem	Flanged or screwed	100, 125, 150, 200, 250 Size range : ¼in to 3in

Launches and Trial Trips

ONDO, cargo liner ; built at Belfast by Harland and Wolff, Ltd., for Elder Dempster Lines, Ltd. ; length between perpendiculars 425ft, breadth moulded 62ft, depth moulded to shelter deck 34ft, gross tonnage 5500 ; four main cargo holds, sixteen derricks, electric winches, four 125kW diesel-driven generators ; Harland and Wolff two-stroke, single acting, opposed piston diesel engine, five cylinders, 620mm diameter by 1870mm combined stroke, 115 r.p.m.—Launch, June 7th.

KAIMAI, cargo ship ; built by Henry Robb, Ltd., for the Union Steam Ship Company of New Zealand ; length between perpendiculars 250ft, breadth moulded 41ft 6in, depth moulded to upper deck 17ft 9in, deadweight 2100 tons on 16ft draught ; trial speed 11 knots ; four holds, electric winches, eight 5-ton derricks, three 114kW diesel-driven generators ; Clark-Sulzer mark TPD 48, five-cylinder diesel engine, 1500 b.h.p. at 225 r.p.m.—Launch, June 8.

SAN FLAVIANO, oil tanker ; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for the Eagle Tanker Company, Ltd. ; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, summer draught 29ft 8in, deadweight 18,000 tons ; thirty-three oil cargo compartments, one main cargo pump room, ; two 550kW turbo-alternators, one 200kW diesel-driven alternator ; one set of double reduction geared compound turbines, 8250 s.h.p. ; two Babcock and Wilcox water-tube boilers provide steam at 500 lb per square inch and 800 deg. Fah.—Launch June 12th.

FRANK JAMIESON, tug ; built by Henry Robb, Ltd., for the Ribble Navigation and Preston Docks Board ; length overall 92ft, breadth moulded 23ft, depth moulded 11ft 6in, mean draught 9ft ; two five-cylinder Crossley, two cycle, diesel engines, total b.h.p. 740 at 300 r.p.m.—Launch, June 12th.

CRUX, open shelter deck cargo ship ; built by Alexander Stephen and Sons, Ltd., for Det Bergenske Dampskipsselskab, Norway ; length 400ft, breadth 57ft, depth 25ft, draught loaded 23ft, deadweight 6530 tons, loaded service speed 14½ knots ; twelve passengers ; five cargo holds, one 50-ton and one 30-ton and also a complement of 3-ton, 5-ton and 10-ton derricks ; electric winches ; three 180kW diesel-driven generators ; Stephen-Doxford two-cycle, opposed piston oil engine, four cylinders, 670mm diameter by 2320mm combined stroke.—Launch, June 14th.

SOLFONN, oil tanker ; built at Belfast by Harland and Wolff, Ltd., for Skibs A/S Dalfonn, Norway ; length overall 649ft 9in, length between perpendiculars 615ft, breadth moulded 84ft, depth moulded 49ft, deadweight 29,650 tons ; thirty cargo oil compartments, ten 'tween deck ballast tanks, one main cargo pump room ; two 800kW, 60 c/s, turbo-alternators, two 250kW, 60 c/s diesel-driven alternators ; one set of double reduction geared compound turbines, 12,500 service s.h.p. at 112 propeller r.p.m., two Babcock and Wilcox water-tube boilers supply steam at 450 lb per square inch and 750 deg. Fah.—Trial, June 15th.

Catalogues and Brochures

MACHINE PRODUCTS, Ltd., Kembrey Street, Swindon, Wilts.—Publication entitled "Die-Pressed, Sintered Metal Components," illustrating how high-strength parts can be manufactured by the use of new powdered metal processes. The publication deals in order with the selection of parts suitable for powder metallurgy production and then with the sequence of operations.

SOLIGNUM, Ltd., Dagenham Dock, Essex.—Booklet and shade card describing the use of Solignum on wood to combat such things as dry rot, woodworm, white ants, &c. Solignum wood preservative is now also made in a colourless grade, both for interior and exterior use, and wood so treated can then be painted without fear of the preservative affecting the paint. The booklet is a guide, showing how best to defeat the enemies of timber.

A. E. CAWKELL, 6-8, Victory Arcade, The Broadway, Southall, Middlesex.—Brochure entitled "The Non-Destructive Testing of Engineering Materials." Two instruments are described for measuring certain properties of engineering materials. The "SCT" equipment is suited to research and control work in the laboratory, whilst the "UCT" equipment is more suited to work on complete structures, where material thickness of between a few inches and many feet can be tested. Applications for concrete testing, using "UCT" equipment, are described and the brochure concludes with reference to rocks, ceramics, coal, soil cements, timber, textiles, plastics, &c.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTE OF MANAGEMENT

Mon., July 16th.—Management House, 8, Hill Street, London, W.1, Special Educational Meeting. Speakers, T. M. Hill and E. D. McGarry, 2.30 p.m.

CHEMICAL SOCIETY

Mon. to Thurs., July 16th to 19th.—The University College of North Staffordshire, Keele, Staffordshire, Symposium on "Chemisorption."

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., July 17th.—LONDON BRANCH : Works visit to Lafarge Aluminous Cement Company, Ltd., West Thurrock, Essex, 10.15 a.m. (Westminster Pier).

INSTITUTE OF PHYSICS

Wed. to Sat., July 11th to 14th.—NON-DESTRUCTIVE TESTING GROUP : H. H. Wills Physical Laboratory, Bristol, Summer Meeting, "Physics of Some New Aspects of Non-Destructive Testing."

INSTITUTIONS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERS

Sat., July 14th.—MIDLAND GRADUATE AND STUDENT SECTIONS : Joint Summer Visit to Claerwen Dam, Wales, 9 a.m. (Civic Centre, Broad Street, Birmingham).

INSTITUTION OF ELECTRICAL ENGINEERS

Sat., July 28th.—LONDON GRADUATE AND STUDENT SECTION : Summer Outing, 1956. Visit to the College of Aeronautics, Cranfield, combined with a visit to Woburn Abbey, 8.30 a.m. (Savoy Place, W.C.2.)

INTERNATIONAL MACHINE TOOL EXHIBITION, 1956

To-day, July 6th.—Olympia, London, 9.30 a.m. to 6 p.m.

OLD CENTRALIANS

Fri., July 13th.—Mapleton Restaurant, 39, Coventry Street, London, W.1, "Population," C. M. R. Balbi, 12.45 p.m.

* Three methods are described : Method A, Cell type oven method ; Method B, Oven method ; Method C, Oxygen pressure method.